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OF THE

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[November 6, 1929]

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SEVENTEENTH ANNUAL REPORT
OF THE
SECRETARY OF COMMERCE

DEPARTMENT OF COMMERCE,
OFFICE OF THE SECRETARY,
Washington, November 6, 1929.

To the PRESIDENT:

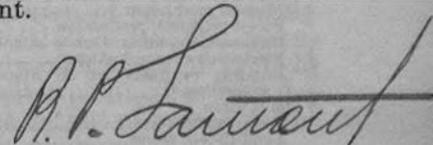
I have the honor to submit herewith for transmission to Congress the Seventeenth Annual Report of the Secretary of Commerce in five parts, as follows:

Economic Review.
Foreign Trade.
Elimination of Waste.
Progress in Development of Civil Aeronautics.
Condensed Reports of Bureaus:

Chief Clerk and Superintendent.
Aeronautics Branch.
Radio Division.
Bureau of the Census.
Bureau of Foreign and Domestic Commerce.
Bureau of Standards.
Bureau of Fisheries.
Lighthouse Service.
Coast and Geodetic Survey.
Bureau of Navigation.
Steamboat Inspection Service.
Patent Office.
Bureau of Mines.
Inter American High Commission.

The report has been prepared for transmission to Congress, as required by the organic act of the department.

Very sincerely,



Secretary of Commerce.

ECONOMIC REVIEW

The output of American industry during the fiscal year ended June 30 was the highest ever attained. Although business was not characterized by the feverish activity of the war period and the immediately succeeding boom, the actual production of commodities and services was larger.

The most comprehensive measure of the volume of industrial production is the general index of output of manufactured commodities compiled by the Federal Reserve Board. This index for the fiscal year just closed stood at 117 as compared with the average for the three years 1923-1925 taken as 100. It was nine points higher than the previous peak, attained in 1927. The activity of the factories was high throughout every month of the fiscal year, most of these months showing an index above that of the corresponding month of any previous year. When adjustment is made for seasonal variations there was relatively little change in volume of output from July until December, but thereafter a decided advance appeared. The index of factory production for June, 1929 (adjusted for the number of working days and for seasonal variation), was 27 per cent above the average month of 1923-1925 and 13 per cent above the highest month of any fiscal year preceding 1928-29; as compared with June, 1928, itself a month of high industrial activity, the index showed substantially the same ratio of advance.

Major economic indexes

[Based on calendar years 1923-1925=100]

Item	Year ended June 30—								June—	
	1922	1923	1924	1925	1926	1927	1928	1929	1923	1929
Volume of business (quantities, not value):										
Manufacturing production.....	75	98	97	99	107	108	106	117	111	127
Mineral production.....	69	93	101	98	99	114	103	111	101	118
Forest products, production.....	80	96	100	99	103	93	93	85	97	90
Railroads, ton-miles revenue freight.....	79	96	97	98	105	111	104	110	100	109
Electric-power production.....	72	88	95	102	116	129	138	154	140	155
Building contracts let, 37 States, square feet ¹	74	91	93	95	122	108	116	112	142	110
Value of sales:										
Department stores.....	85	94	99	100	104	106	107	109	105	112
5-and-10-cent stores.....	69	81	93	104	118	131	144	157	153	174
Mail-order systems.....	64	82	92	103	118	120	132	166	137	176
Wholesale trade.....	85	97	99	99	101	96	96	98	102	106

¹ Adjusted for normal seasonal variations and in the case of manufacturing and mineral production for differences in the number of working days in the month.

² Indexes prior to January, 1925, based on estimates furnished by the F. W. Dodge Corporation.

Aggregate mineral production and the volume of freight transported by the railroads were also very large during the fiscal year, although slightly less than in 1926-27 when both of them had been swollen

by large production and transportation of coal caused by the strike of British miners. The only general indicators of business activity shown in the preceding table which stood at a lower level in 1928-29 than in the preceding fiscal year were the floor space of building contracts and the output of forest products which is largely dependent on construction activity. The decrease in volume of building was only about 4 per cent, and it was still much above the figures of a few years ago.

Since prices of commodities during recent years have been very stable, the statistics of value of sales of mercantile establishments may be taken as reflecting fairly closely the true changes in quantity of commodities sold. The index of wholesale sales shown in the preceding table hardly shows correctly the longer trends in domestic trade because of the increasing tendency toward direct selling by original producers to retail establishments, or even to final consumers. Department-store sales are more significant indicators, and these have shown a gradual increase during every recent year. The very marked expansion in the value of sales of chain stores and mail-order systems is partly due to the increase in the number of stores and in the scope of commodities handled, but no doubt in part it reflects a general increase in sales of goods to consumers.

A conspicuous and gratifying feature of American business during the last eight years is well brought out by the major statistics of production and trade, namely, its steadiness. There have been neither sharp booms nor sharp slumps. With two or three minor and short-lived recessions, the upward trend of production and consumption has been gradual, but in the aggregate considerable.

A number of important individual mine and factory products show considerably greater gains in output during 1928-29 as compared with the preceding year than are revealed by the general indexes of the production of manufactured goods and minerals. The output of steel ingots, which reflects demand for machinery, automobiles, steel construction, and the like, was decidedly the greatest ever attained, the increase over 1927-28 being nearly 22 per cent. The number of automobiles produced, a very significant measure of the buying power of the people, was likewise larger than during any corresponding previous period, although part of the increase of over 52 per cent as compared with 1927-28 was due to abnormal conditions in the earlier year, involving the temporary cessation of production by one of the largest concerns. The production of copper, largely as the result of rapid expansion in the electrical field, was also exceptionally great, the increase above the already high levels of 1927-28 being about 22 per cent, as measured by smelter production from domestic ore. Marked gains appear also in the output of refined petroleum products and of rubber tires.

The high activity of manufacturing and mining industry during the fiscal year just closed was accompanied by larger employment of labor and reduction in part-time work. For some years during the early part of the decade, notwithstanding the general prosperity prevailing, there was a slow decline in the number of workers in factories, as the result of the introduction of more efficient labor-saving machinery and other improvements in methods of production. In

the absence of statistics of unemployment there is no way of knowing whether this reduction in the number working in factories, together with the decrease also occurring in the number employed on farms and on railways, resulted in a greater volume of unemployment. It is known that there has been a marked increase in the number working in various other fields, notably in the so-called service occupations, but little precise statistical information regarding this trend is available.

Throughout our history a gradual shift has been taking place in the occupations of the people. The proportion engaged in producing necessities of life has steadily fallen, more and more labor being set free to produce advanced commodities and services characteristic of a higher standard of living. For a long time this movement was reflected in a steady expansion of employment in factory industries as well as in distribution and in service occupations, agriculture being almost the only branch of industry to lose, relatively, in the number of workers. For some time after 1920, however, the trend toward service occupations was so strong as to bring about an absolute reduction in the number of factory employees. This downward movement has been checked during the last three or four years, and the number of factory workers employed during the fiscal year 1928-29 was appreciably greater than during the preceding fiscal year. It is probable that the census of manufactures covering the calendar year 1929 will show more wage-earners in American factories than the census of 1925.

The general increase in the production of farm, factory, and mineral commodities in the United States during recent years, in the face of a stationary or even slightly declining number of workers in these fields, is the effect of steady improvement in the efficiency of American industry. This advance in efficiency, although possibly more marked since the war than before it, is nevertheless merely a continuation of a long historical process of economic advance. Statistics showing the increase in output per man in the major branches of industry as compared with the closing year of the last century, and as compared with 1919, were presented in the annual report of my predecessor for the fiscal year 1927-28 under the title "Progress in national efficiency." It was there shown that in each of the four branches of agriculture, manufactures, mining, and railway transportation the amount of product or service turned out per man during 1927 was from about 50 to over 100 per cent greater than it had been less than three decades earlier. The data for 1928 show a further gain.

The last annual report of the Secretary of Commerce discussed also some of the major causes of this advance in the productivity of industry. Among these the most important are perhaps the expansion and improvement in the education of the people, the great attention devoted to scientific research, the systematic pursuit of invention and discovery, the use of more and more machinery and other forms of capital, the increasing employment of mechanical power, the large scale of enterprise permitting greater application of mass methods, the conscious and concerted effort to eliminate waste and to secure economies in production and distribution, the high

scale of wages and the consequent large buying power of the masses of people, and the comparative stability of prices and of credit in this country.

Most of these causes which have served to increase the efficiency of industry and to advance the standards of living are, fortunately, of an enduring character. They tend even to work cumulatively, so that it may be said that it becomes easier each year to achieve further progress.

PRICES

The high activity of business in the past fiscal year was accompanied by no general upward trend of prices. The steadiness of price levels, which has been characteristic now of a very considerable period of time, continued. The stability of wholesale and retail prices since 1922 has been an important factor in keeping business steady and large. It is a noteworthy fact that the extreme monthly range in the movement of the general wholesale price index during the last seven years has been only 10 per cent, the highest point being in March, 1923, and the lowest in May, 1927. The index for the fiscal year 1928-29 taken as a whole averaged about 1 per cent higher than for the preceding fiscal year and about 5 per cent lower than for the year 1925-26, which had shown the highest annual average since the depression period. The highest price levels of the fiscal year just closed were attained in September, 1928, and the lowest in May, 1929, the difference between the two figures being only about 4 per cent. The fact that there was an actual decline in price levels of commodities during the course of the year is an indication that the high activity of industry was not in the nature of an inflationary boom.

Steadiness has characterized not only the general index of wholesale prices but likewise the indexes covering the several major groups of commodities. For the year 1928-29 as a whole the average prices of farm products in central markets were practically the same as in the preceding year, though appreciably higher than in 1926-27 or than in the years from 1922 to 1924. In 1928-29 prices of hides and leather and their products, which had advanced considerably during the preceding year, fell off slightly, and the group of miscellaneous commodities, which is largely affected by the price of rubber, fell somewhat as the result of the abandonment of the scheme of restriction of shipments from the British rubber-producing areas of the Far East. The very great demand for metals, characteristic of a period of expansion in the construction of plants and machinery and of automobiles and similar conveniences, resulted in an advance of about 5 per cent in the index of metal prices, though even so it stood somewhat lower than a few years ago.

Retail prices in recent years have shown even less variation than wholesale prices. After the sharp break from the peak levels of the immediate postwar boom, the extreme range of changes in the semi-annual indexes of cost of living has not been more than 5 or 6 per cent. There was practically no change during the last two fiscal years, the indexes standing slightly lower than from 1925 to 1927.

Revised general wholesale price index and other price indexes

[Based upon calendar year 1926=100]

Annual averages	Year ended June 30—									
	1913 ¹	1922	1923	1924	1925	1926	1927	1928	1929	1929 ²
Wholesale prices (revised):										
General average.....	69.8	93.7	101.2	98.1	100.5	102.5	95.8	96.6	97.4	139.5
Farm products.....	71.5	90.5	96.8	98.0	106.6	106.2	96.3	104.8	105.0	146.9
Food.....	64.2	86.8	91.6	90.7	95.8	101.5	97.4	98.6	100.3	156.2
Hides and leather.....	68.1	104.2	107.7	100.8	104.8	101.9	101.1	118.8	114.0	167.4
Textile products.....	67.3	95.9	108.0	108.5	107.2	105.0	95.9	96.8	95.7	167.2
Fuel and lighting.....	61.3	94.6	110.4	92.3	92.5	97.8	95.1	82.4	82.9	135.2
Metals and metal products.....	90.8	105.9	106.4	107.9	104.5	100.3	99.6	98.0	103.0	113.4
Building materials.....	56.7	92.4	106.9	105.2	101.3	100.7	97.6	92.0	96.3	169.8
Chemicals and drugs.....	80.2	105.4	101.1	99.1	100.3	101.5	98.2	96.0	95.2	118.7
House-furnishing goods.....	56.3	104.6	106.8	107.2	104.2	101.6	106.8	98.3	96.7	171.8
Miscellaneous.....	93.1	96.4	97.4	95.4	96.4	112.5	92.2	87.4	80.0	85.9
Farm prices on the farm.....	74.0	88.0	96.0	97.0	104.0	105.0	95.0	101.5	101.0	137.3
Retail prices.....	62.3	90.9	89.0	91.3	93.3	100.6	98.6	95.5	96.1	154.8
Cost of living:										
December.....	56.9	99.3	96.5	98.6	98.2	101.3	100.0	97.8	-----	-----
June.....	57.2	95.2	97.1	96.7	99.3	100.0	99.2	97.0	97.1	170.2

¹ Calendar year.² Based upon calendar year 1913=100.

AGRICULTURE

There was some improvement in the agricultural situation during the fiscal year 1928-29, viewing the industry as a whole. Legislation creating the Federal Farm Board was an important step forward to facilitate distribution of agricultural products and thereby to aid the farmer. With an increase of 2 per cent over the year ended June 30, 1928, the gross income from farm products (after deducting the value of crops fed or used for seed) totaled \$12,527,000,000, the largest, except for 1925-26, since 1920-21, and approximately one-third more than in 1921-22. If allowance is made for the buying power of money, the value of agricultural production in 1928-29 was larger even than in 1920-21. The increase over the preceding year was the result of larger receipts from livestock and livestock products. Producers of grain and vegetable products, particularly those growing wheat and potatoes, received smaller gross income than in the fiscal year preceding, but producers of cotton, the principal cash crop of the South, had about the same income as the year before, the increased output being about offset by decreased prices.

As shown in the price section of this review, prices of farm products both at the farm and central markets in the fiscal year 1928-29 were approximately the same as in 1927-28. As compared with 1913, however, central market prices of farm products were 46.9 per cent higher, while the price level of all commodities covered by the general index was only 39.5 per cent higher; prices at the farm for farm products were 37.3 per cent higher. On June 15, 1929, the farm price of wheat was 1.6 cents per bushel lower than the 5-year pre-war average price.

The following table, compiled from data of the Department of Agriculture, shows the changes during the past decade in the aggregate value of farm crops and animal products, the value of products fed or used for seed, and the resulting income from production. Of the total of \$12,527,000,000 for the fiscal year ended June 30, 1929,

about 55 per cent was represented by the value of livestock and livestock products; this fraction has been tending gradually upward. Moreover, a much larger proportion of grain and other vegetable products of the farm is exported than in the case of animal products; cotton is much the largest item in the list of American exports. It follows that the proportion of meats and dairy and poultry products consumed by the American people is very high—much higher than in most European countries.

Estimated value of farm products

[In millions of dollars]

Year ended June 30—	Crops	Animals and animal products	Crops fed to livestock and used for seed	Gross income, excluding crops fed to livestock and used for seed
1920	17,081	6,944	8,306	15,719
1921	11,970	5,830	5,132	12,668
1922	8,085	4,809	3,080	9,214
1923	9,772	5,137	4,543	10,300
1924	10,767	5,482	4,961	11,288
1925	11,209	5,877	5,083	12,003
1926	10,558	6,437	4,325	12,670
1927	9,829	6,658	4,360	12,127
1928	10,652	6,501	4,849	12,304
1929	10,288	6,856	4,617	12,527

The latest available estimates of crop production in 1929 indicate larger cotton, tobacco, and hay crops but smaller production of potatoes and cereal crops than in 1928; the smaller output of corn and oats being due to both reduced acreage and lower yield per acre, while a smaller production of wheat and barley results entirely from lower yield per acre caused by drought.

As pointed out in the last annual report of this department, under the heading "Progress in national efficiency," agricultural production in 1926-27, expressed in quantitative terms, was about 55 per cent greater than at the beginning of the century, substantially the same increase as in population, but the increase of 18 per cent since the close of the World War was appreciably greater than that in population. The number of persons on farms at present is practically the same as in 1900 and considerably smaller than in 1919. These data, therefore, show a very marked gain in output per farm worker. The increase in agricultural production, however, has been much less rapid than that in the production of manufactured and mineral products. This is due to the fact that farm products for the most part are necessities of life, and it is natural that the demand for necessities should expand little if any more rapidly than the number of inhabitants. Manufactured commodities, many of which are in the nature of semiluxuries, or in the nature of additions to the capital equipment of the Nation, have a demand almost unlimited; even though at a given time the need for this or that particular class of factory products may be fully met, new and more highly elaborated articles are constantly being brought out and the consumption of many of these grows very greatly.

CONSTRUCTION

As already stated, building construction, considered as a whole, is one of the few branches of business which was less active in 1928-29 than the year before. The decline was slight, amounting to 3 or 4 per cent in the floor space of buildings for which contracts were awarded and to 5 per cent in the value of construction contracts for buildings and public works. Moreover, the decline was confined largely to residential buildings, the contracts for commercial, industrial, and public buildings showing a considerable increase. The 12-month period was notable for the initiation of a considerable number of large bridge and other engineering construction projects, including several large pipe lines from southern and southwestern gas and oil producing fields to areas farther north, including Denver and Chicago.

The relationship of credit conditions to residential and other construction has been a subject of much concern. We have been putting annually from \$2,000,000,000 to \$3,000,000,000 into new homes for the people—a sum equal to one dollar out of every thirty or forty of the total national income. The new dwellings constructed in recent years have, in general, been better and more convenient than those previously in use, and have contributed to higher living standards, which have been made possible by higher per capita income.

It is important for stable business and employment conditions, as well as for the welfare of our people, that this great volume of construction should proceed at a reasonably steady rate. In the closing months of the fiscal year 1927-28 letting of building contracts proceeded in larger volume than in any corresponding previous period. Some reaction followed at various points where speculative or operative builders had overanticipated the actual demand for certain classes of structures.

A growing shortage of adequate long-term credit at reasonable rates of interest produced somewhat uneven effects in different cities. Up to the close of the fiscal year soundly managed construction projects for which there was a real demand were in some cases curtailed but generally were able to go ahead. During the middle and late summer and early autumn, however, inability of builders and owners in many instances to obtain even conservative first-mortgage loans, and of municipalities to float bond issues at reasonable prices, was instrumental in checking, to a serious degree, needed construction that would have gone ahead if it had not been for diversion of credit resources to finance speculation in securities.

Construction statistics

[Based on calendar years 1923-1925=100]

Item	Year ended June 30—							
	1922	1923	1924	1925	1926	1927	1928	1929
Indexes of volume of business:								
Construction contracts awarded—								
Value, including public works and public utilities, 36 States.....	(1)	(1)	88	101	129	130	133	126
Floor space of buildings, 36 States.....	(1)	(1)	92	95	122	107	116	113
Cement shipments.....	71	90	93	105	108	113	116	118
Lumber production.....	80	96	100	99	103	93	93	83
Price indexes:								
Frame-house materials, retail.....	(1)	99	103	98	97	95	90	88
Building-material prices, wholesale.....	89	103	101	97	97	94	88	92

¹ Comparable data not available.

TRANSPORTATION

The net operating income of Class I railways (which represent about 98 per cent of the total railway business) during the fiscal year ended June 30, 1929, was the largest ever reported, exceeding the figure for the preceding year by 20 per cent, and the figure of 1926-27 by 7 per cent. The gain over 1927-28 was due partly to the large traffic and partly to economy in operation as the result of which expenditures increased very little while gross revenues rose materially. The volume of freight traffic handled (ton-miles of revenue freight) from January to June, 1929, was larger than in the first half of any other year on record. For the entire fiscal year the ton-mileage was 6.4 per cent more than in 1927-28, although slightly less than in 1926-27, when traffic had been swollen by the large coal movements resulting from the strike of the British miners and from other causes.

Operating statistics of Class I railways

[Source: Interstate Commerce Commission and Bureau of Railway Economics]

Item	Year ended June 30—					
	1922	1925	1926	1927	1928	1929
Freight ton-mileage (millions):						
Revenue.....	313,439	396,621	427,385	449,285	420,312	447,024
Nonrevenue.....	38,097	40,766	43,398	46,192	44,330	44,763
Tons of revenue freight originated (thousands).....	940,056	1,210,118	1,273,048	1,351,076	1,246,228	1,320,086
Cars loaded (thousands).....	40,658	49,678	51,905	53,627	50,576	52,716
Net tons per train, average.....	656	731	752	786	776	803
Net tons per loaded car, average.....	26.8	27.0	27.0	27.6	26.7	26.8
Average daily car surplus.....	272,756	252,410	218,779	213,154	303,408	232,378
Average daily car shortage.....	2,410	295	455	287	133	57
Bad-order cars, average number.....	339,369	194,519	172,252	144,668	141,508	142,672
Bad-order locomotives, average number.....	15,764	11,514	10,478	9,302	8,880	8,343
Employees, average number.....	1,643,000	1,765,000	1,782,733	1,798,495	1,711,200	1,679,553
Total operating revenues (thousands of dollars).....	5,508,169	6,011,864	6,325,158	6,442,387	6,096,483	6,334,043
Net operating income (thousands of dollars).....	818,345	1,033,766	1,194,832	1,209,535	1,074,341	1,294,470

The large traffic of 1928-29 was handled with fewer employees, fewer freight cars, and fewer locomotives than in any other year of similar volume of business. The use of larger cars and more powerful locomotives, permitting the hauling of heavier trains, has tended gradually to raise the average amount of freight carried per person employed on the railways. In the last fiscal year the average weight of revenue freight hauled per train was 803 tons as compared with 776 the year before and 656 in 1921-22. The new cars and locomotives which are being added from time to time are of much larger capacity than those installed 20 or 30 years ago or even 10 years ago.

The quality of service furnished by the railways, as well as by other public carriers, is better now than at any other time in the history of the country. Shortages of cars have now become rare occurrences. At present it takes scarcely two-thirds as long to move goods a given distance as it did a decade ago. With the increasing efficiency with which traffic is being handled, producers are able to make quicker deliveries and distributors are able to carry smaller stocks and to turn over their capital more quickly. As a result goods are cheapened to consumers.

One of the important factors in the recent efficiency and economy of railway operations has been the reduction in the number of cars and locomotives out of order. For several years past there has been little change in the average proportion of bad-order cars, but the figure is less than one-half as great as it was about a decade ago. The number of bad-order locomotives has steadily declined and in 1928-29 was considerably less than in any previous year. It is also an advantage to the railways to keep their cars in use as much of the time as possible consistently with the avoidance of car shortages. While an unduly small surplus of cars for loading is injurious to shippers, an unduly large surplus may represent a lack of demand for transportation. The average daily car surplus in 1928-29 was less than in most recent years, but the fact that there were almost no instances of shortage of cars shows that the equipment available was fully adequate to the needs of shippers.

The situation of American ocean shipping during the year 1928-29 was somewhat more satisfactory than in recent preceding years. Although there was a slight decline in the total capacity of seagoing vessels registered under the American flag, there was a marked reduction in the tonnage of idle vessels and a considerable increase in the tonnage actually active in seagoing foreign and domestic trade.

The tonnage of seagoing steel and iron steam and motor ships (of 100 gross tons or larger) registered under the American flag was 10,745,000 gross tons on June 30, 1929, or 1 per cent less than the year before. The decline was much less marked than during most of the years since 1921, at which time, as the result of the feverish construction of ships during the World War emergency, our merchant marine reached its maximum figure. The capacity of seagoing ships of the character mentioned was nearly 13 per cent less at the close of the last fiscal year than in 1921. The relative decrease in ships engaged in foreign trade has been much greater, since there has been a considerable addition to the fleet engaged in coastwise trade, including vessels trading from coast to coast through the Panama Canal.

Six or seven years ago over half of the American seagoing merchant tonnage was idle. The amount of idle tonnage has been more than cut in two since that time, partly as the result of the scrapping of vessels, but partly through putting them into service. The capacity of idle vessels on June 30, 1929, was 2,253,000 gross tons, which was 26 per cent less than one year earlier; the corresponding figure for January 1, 1923, had been as high as 5,328,000 tons. During the past fiscal year the idle vessel tonnage of foreign countries declined even more than that of the United States, and in the world as a whole a new low postwar record for idle shipping was reached, namely, 3,312,000 gross tons, or 29 per cent less than on June 30, 1928.

The fiscal year witnessed a continuance of the movement of recent years to shift vessels from Shipping Board ownership to private ownership. The active Shipping Board tonnage was reduced by 241,000 gross tons. On the other hand, there was an increase of 727,000 gross tons in active seagoing shipping privately owned, the gain amounting to nearly 13 per cent. This increase consisted largely in additions of general cargo vessels and combination passenger and cargo vessels for use in oversea foreign trade.

By reason of the overconstruction of vessels in the United States during and immediately after the World War, the American ship-

yards have been relatively inactive during recent years. The amount of shipping under construction was less at the end of the last fiscal year than it had been at the beginning, amounting to 151,000 gross tons as compared with 223,000 (these data include lake and river vessels as well as ocean vessels). A number of foreign countries at present are building many more ships than the United States.

In conformity with the increase in value of our foreign trade, the total weight of cargo carried in 1928-29 to and from the United States ocean ports was $6\frac{1}{2}$ per cent greater than in 1927-28. Little change took place in the relative extent to which American shipping participated in the carriage of our imports and exports. Including ocean and Great Lakes trade with foreign countries American vessels carried almost exactly one-third of the total value of the commodities transported by water. This proportion had reached its maximum in 1920, when it amounted to about 43 per cent, but the present share of American vessels is much higher than before the World War, when it was in the neighborhood of 10 per cent. The share of American ships in the transportation of cargo to and from foreign countries, as measured by weight, is considerably higher than that as measured by value, being approximately one-half in the case of imports and one-third for exports.

An interdepartmental mail contract committee was set up by the President in April, 1929, for the purpose of obtaining basic information necessary for the solution of the problems of ocean mail contracts, and of making recommendations to the administration. This committee and its subcommittee are at work collecting the statistical and other data required.

Very rapid progress was made during the last fiscal year in the field of aviation. Whereas this country, a few years ago, lagged behind a number of European nations in the volume of air traffic, it now outranks any other country in this respect and is making more rapid advance than any other important country. The subject is more fully discussed in a special section of this review.

BANKING AND FINANCE

Two financial movements of the fiscal year were of a striking nature. There was an expansion of the investment trust unlike anything in American financial history; and there were literally scores of important bank mergers. Although investment trusts were hardly known in this country four years ago, nearly a quarter of the capital issues floated in the United States during the first six months of 1929, or about \$800,000,000, were investment-trust securities. Somewhat allied to the development of both investment trusts and bank mergers was the creation of chain banks by holding companies.

Three other conspicuous movements of the year were the large advance of stock prices, the expansion of brokers' loans, and the rise of interest rates.

Stock prices continued their sharp upward trend of recent years. There was clear evidence of widespread stock speculation. The older indices, being based on a few market leaders, show a phenomenal rise. Even the newer index of 405 common stocks began the fiscal year at 145.3 and ended it at 188.6. The average price of 40 bonds declined from 97.38 to 93.49 from year end to year end.

Brokers' loans, as reported by the New York Stock Exchange, rose during the fiscal year by \$2,173,000,000, or to slightly over seven billions. More than half of the increase was in loans for the account of others than banks.

Despite the diversion of funds into brokers' loans, commercial loans of approximately 650 weekly reporting member banks increased by about \$3,532,000,000; and new domestic capital issues totaled \$2,366,000,000 (par value, minus refunding) more than in the preceding year.

As was natural in a period of soaring stock values, new stock issues increased by \$2,711,000,000. Notwithstanding the preference for stocks, there was a diminution of only \$345,000,000 (about one-fourteenth) in bond issues, despite the sharp rise in money rates. An unusual proportion of the new bonds, however, were convertible.

Foreign securities publicly offered in the United States totaled \$925,359,000 (par value). This was almost exactly half of the record established in the preceding fiscal year. High interest rates discouraged foreign capital issues, most of which have always been bonds; and a certain volume of investment funds went into brokers' loans which previously would have gone into foreign loans. Much foreign capital came into the country (mostly from Canada) either for brokers' loans or for stock-market speculation, and several financial writers have even declared that the United States had a net import of capital during much of the fiscal year. This opinion can not be tested, however, without a detailed survey of international payments during the fiscal year.

All money rates in the open market at New York rose abruptly with hardly a recession; bankers' acceptances from a monthly average of $4\frac{1}{8}$ per cent at the beginning of the year to $5\frac{1}{2}$ per cent at its close, time loans (90 days) from $5\frac{1}{8}$ - $5\frac{1}{4}$ to 8 - $8\frac{1}{4}$ per cent; new call loans from 6.21 to 7.83 per cent; and Treasury certificates from 3.92 to 4.89 per cent.

The policy of the Federal reserve banks was largely directed toward restricting funds available for brokers' loans without unduly hampering commercial credit. With the cooperation of the banking community, a broad "spread" was always maintained between the rates for brokers' loans and those for commercial paper, the former having been often more than double the latter. In July, 1928, seven of the reserve banks raised their discount rates from $4\frac{1}{2}$ to 5 per cent, and the other five followed suit later in the fiscal year. During the period Federal reserve credit outstanding (holdings of securities plus investments in Government securities) was deflated by about one-seventh, or by \$205,000,000. On the other hand, Federal reserve notes in circulation increased by \$54,000,000. Total gold reserves increased by \$312,000,000, and the gold ratio rose from 68.7 to 75.3 per cent. These changes are computed from the week-end reports for June 27, 1928, and June 26, 1929.

Early in the fiscal year there was a very important reversal of the gold movement. In 1927-28 the United States had a record-breaking net gold export of \$497,962,000; in 1928-29 the net import of gold was \$155,137,000. The causes of gold movements are difficult to trace, but this reversal was perhaps mainly the result of the decline in our foreign lending and our continuing excess of merchandise exports.

For years progressive bankers in this country have sought to expand our acceptance market—to reduce the cost of commercial credit, to gain the profits and prestige of an international short-term credit center, and to enhance the supply of short-term self-liquidating paper. The healthy growth in “acceptances outstanding” is, therefore, one of the more favorable financial developments of the year. The total for June 29, 1929, doubled the figure for five years earlier and was nearly \$90,000,000 more than the figure for one year earlier. The greatest growth was in acceptances covering movements of goods between foreign countries; this financing is less likely to fluctuate seasonally than that connected with our own exports and imports.

The rapid retirement of the public debt continued. Total interest-bearing debt of the United States Government on June 30, 1929, was about \$16,639,000,000. This is about \$679,000,000, or nearly 4 per cent, less than the amount one year earlier and about \$8,600,000,000 less than for 10 years earlier. Our per capita national debt was thus reduced in one year by more than \$5. Comparable statistics for the year on the debts of States and minor political divisions are not available.

Bank clearings set a new high record. “Debits to individual accounts” in the last five fiscal years have been as follows—in rounded billions of dollars—531, 597, 630, and 865. Numerous other captions of American financial statistics deal with billions of dollars; this is approaching the trillions. The growth in check payments in recent years has been greatly accelerated by broader stock-market trading at higher levels.

FOREIGN TRADE

A general discussion of the recent trends of American foreign trade is presented in a separate section of this report. During the fiscal year 1928–29, export trade, when adjustment is made for changes in prices, was greater than in any previous fiscal year of our history and 10 per cent larger than in 1927–28. The increase in sales abroad was shared by all the economic groups except that of crude foodstuffs, but a large part of the total gain was in exports of various advanced manufactures. The total value of our foreign sales of the group of finished manufactures reached more than \$2,500,000,000, showing an increase of 22 per cent over 1927–28. The volume of imports tends to be high in times of prosperity and low in times of depression. The value of our purchases abroad during the last few years, however, has been much affected by a downward trend in the prices of several major import commodities. That value in the fiscal year 1928–29 was $3\frac{1}{2}$ per cent greater than the year before, but, taking account of price changes, it is estimated that the imports increased about 9 per cent.

Our exports to each of the great trade regions of the world were greater in 1928–29 than the year before. The percentages of increase were particularly high in the case of South America, Asia, Africa, and Canada. Sales to Europe showed relatively little increase. The dollar value of imports from most of the trade regions also increased. The most marked expansion was in the imports from Africa and from South America. Because of the decline in prices of rubber and tin the value of our purchases from Asia showed only an insignificant

increase, and because of the fall in the price of sugar total import from the Latin countries and islands of North America fell off slightly in value.

The so-called favorable balance of our trade (excess of exports over imports of merchandise) during the fiscal year just closed was larger than in any year since 1921-22, amounting to \$1,082,000,000. Partly as a result of this large balance to our credit on merchandise transactions, but also under the influence of stock speculation and other factors, there was a net import of gold to the amount of \$155,000,000, in great contrast with the net export of nearly \$500,000,000 of gold during 1927-28.

FOREIGN TRADE

GENERAL PROGRESS AND TENDENCIES

[By WILLIAM L. COOPER, Director, Bureau of Foreign and Domestic Commerce, and E. DANA DURAND, Statistical Assistant to the Secretary of Commerce]

The export trade of the United States during the fiscal year 1928-29 was 10 per cent greater in value than the year before and 43 per cent greater than in 1921-22, and when adjustment is made for changes in prices it materially exceeded the foreign sales in any previous fiscal year of our history. Although the increase as compared with 1927-28 was shared by all the great economic groups except that of crude foodstuffs, which declined because of a marked reduction in shipments of wheat, the gain was greatest in the class of finished manufactures, many individual manufactured articles showing remarkable expansion. The value of imports increased by 3½ per cent over the preceding year and the gain would have been much greater but for the decline in price of a number of major import commodities.

Foreign trade of the United States

[Millions of dollars]

Item	Year ended June 30—1					Per cent increase, 1929 over—		
	1910-1914	1922	1927	1928	1929	1910-1914	1922	1928
Exports of United States merchandise.....	2,130	3,700	4,867	4,773	5,284	148	43	10.7
Exports, including reexports.....	2,166	3,771	4,968	4,877	5,374	148	43	10.2
Imports, merchandise.....	1,689	2,608	4,252	4,148	4,292	154	65	3.5
Excess of exports (+) or imports (-):								
Merchandise.....	+477	+1,163	+716	+730	+1,082			
Gold.....	+17	-441	-148	+498	-155			
Silver.....	+20	-8	+21	+20	+17			
Quantitative index eliminating the effect of price variations (1913=100): ¹								
Exports of United States merchandise.....	89	116	153	152½	168	89	45	10.1
Imports.....	94	137	176	180	197	110	44	9.4

¹ Minus sign indicates decrease.

² Approximate only.

The trends of the last fiscal year in our foreign trade were for the most part in the nature of a continuance of movements which have persisted for a number of years past and indeed for several decades. The conspicuous upward tendency in the aggregate value of trade in both directions over long periods has been due largely to a very rapid growth in exportation of manufactured goods and in the importation of raw materials for our factories. As a result of this development, there has been a decided shift in the relative position

of the several trade regions. Europe is becoming relatively less important in both our export and our import trade, and the other continents more important.

The great significance of our foreign trade, both on the export and import side, in relation to the prosperity of our industries and the well-being of our people is each year becoming more generally appreciated by the business interests of the country and by all classes of its population. Although the United States has highly varied resources and is exceptionally self-sufficient, nevertheless the high standard of living of its people demands the bringing in of several very important commodities and of many minor commodities which either can not be produced in this country at all or are produced only in insufficient quantities. If we are to pay for a great and increasing volume of imported goods, and at the same time provide the means to pay for services to our tourists and for other similar services rendered to us by foreigners as well as to make investments of capital abroad, we must export large and increasing quantities of our products. Exports represent approximately one-eighth of all that our farms and one-tenth of all that our factories produce. To cut off our export trade would mean direct loss of jobs to two or three millions of our workers and to cut off our import trade would likewise throw great numbers out of employment. Moreover, the attendant shock to general business, should foreign trade cease, would be even more grave.

The exports of the United States during the fiscal year just closed were almost two and one-half times as great in value as the annual average for the five years preceding the World War. Although a large part of this increase is due to higher price levels, the quantitative gain has been not far from 90 per cent. In each of the last eight fiscal years, with the exception of 1927-28, when there was practically no change, our export trade, adjusted to eliminate the effect of price variations, has shown an increase over the year preceding, and in most years the gain has been large. In quantitative terms, our foreign sales in 1928-29 were about 45 per cent larger than in 1921-22.

Our exports are now much greater than those of any other country of the world. Exports of domestic commodities in 1928-29 exceeded the corresponding figure for the United Kingdom, which stands second, by 49 per cent, while aggregate exports, including resales of imported articles, exceeded those of that country by 31 per cent.

The expansion of American foreign trade, however, has been by no means one-sided. Imports have grown, broadly speaking, even more than exports. In terms of dollar value, the imports of 1928-29 exceeded those of the average pre-war year by 154 per cent, as against a gain of 148 per cent in exports. As compared with the fiscal year 1921-22, the increase in value was 65 per cent for imports and 43 per cent for exports, this conspicuous difference being due to the fact that a business depression, such as that of 1921, normally cuts down imports much more than it does exports, so that the import figure of eight years ago was abnormally low.

A considerable difference appears between our exports and our imports as regards the movement of the prices of the major commodities in the trade. Although at present the price indexes of the two

groups of commodities show roughly the same increase over pre-war levels, the index for export articles is now materially lower than it was in 1921-22, while that of import articles is somewhat higher. Consequently, although the increase in value of imports since 1921-22 has been materially greater than that in value of exports, trade in both directions shows substantially the same quantitative increase. However, as compared with the immediate preceding fiscal year, export prices in 1928-29 showed substantially no change, while an appreciable decline appeared in import prices. There was little difference between exports and imports as regards the quantitative increase over 1927-28, both showing a gain of approximately one-tenth. Rubber last year, as in various preceding years, was the commodity which changed most conspicuously in price. While the imports of rubber in 1928-29 were nearly one-third larger than the year before in quantity, the value declined by nearly one-fourth, prices having fallen greatly as the result of the abandonment of the scheme of restriction of exports from the British rubber-producing areas in the Far East. There was, likewise, a marked increase in the amount of sugar imported in the last fiscal year but a decline in its value. Import prices of crude petroleum and tin also fell sharply.

Since exports in the fiscal year just closed increased decidedly more in value than imports, the so-called favorable balance of trade rose to the largest total since 1921-22. It amounted to \$1,082,000,000 as compared with an average of \$618,000,000 for the six years preceding and with \$730,000,000 in 1927-28. Partly as a result of this large balance to our credit on merchandise transactions but also under the influence of stock speculation and other factors, there was a net import of gold last year amounting to \$155,000,000. This was in great contrast with the heavy net export of gold during the preceding fiscal year, which however, had been a very exceptional phenomenon.

The United States has at all times to pay foreigners, by means of an excess of commodity exports or in other ways, very large sums for tourist expenditures, immigrant remittances, and other similar purposes. In most years also a considerable part of the merchandise balance has been used to make new investments of American capital in foreign countries. During 1928-29, however, owing to the strong demand for capital in the United States and especially in the stock market, such investments abroad fell off sharply, while there was an unusually large movement of foreign capital into the American market.

The most conspicuous one feature of the export trade of the fiscal year just closed was the great expansion of the sales of the class of finished manufactures. The total reached the enormous sum of \$2,509,000,000, with a gain of nearly 22 per cent over the preceding fiscal year and of 107 per cent over 1921-22, only seven years before. Our exports of this class of commodities, many of which meet the active competition of the great industrial countries of Europe, were nearly four times as great in value as during the average year immediately preceding the war, and even allowing for the difference in price levels the gain has been more than threefold.

Growth of foreign trade of the United States

[Millions of dollars]

Item	Year ended June 30—					Per cent increase, ¹ 1929 over—		
	1910-1914 average	1922	1927	1928	1929	1910-1914	1922	1928
TOTAL EXPORTS, INCLUDING REEXPORTS OF FOREIGN MERCHANDISE								
<i>To—</i>								
Europe.....	1,350	2,068	2,394	2,322	2,397	78	16	3.2
All other continents.....	816	1,703	2,575	2,555	2,977	265	75	16.5
Canada and Newfoundland.....	320	551	797	871	998	212	81	14.6
Latin America.....	302	536	869	831	971	222	81	17.0
Asia.....	121	480	587	568	685	466	43	20.6
Oceania.....	48	84	216	174	193	302	130	10.9
Africa.....	25	52	106	111	129	416	148	16.5
EXPORTS OF UNITED STATES MER- CHANDISE								
Foodstuffs.....	421	1,144	877	824	806	91	-30	-2.2
Raw materials.....	713	933	1,321	1,174	1,239	74	33	5.6
Semimanufactures.....	342	412	694	714	730	113	77	2.3
Finished manufactures.....	654	1,211	1,976	2,062	2,509	284	107	21.7
GENERAL IMPORTS								
<i>From—</i>								
Europe.....	836	831	1,257	1,258	1,303	56	87	3.5
All other continents.....	853	1,777	2,995	2,889	2,989	230	68	3.5
Canada and Newfoundland.....	119	310	486	492	516	334	66	4.8
Latin America.....	435	679	1,049	1,039	1,080	150	60	4.8
Asia.....	259	705	1,315	1,215	1,223	372	73	.7
Oceania.....	17	31	59	54	57	235	84	6.8
Africa.....	23	52	86	90	104	352	100	15.8
Foodstuffs.....	398	635	968	969	971	144	53	.3
Raw materials.....	595	927	1,651	1,541	1,510	154	63	-2.0
Semimanufactures.....	307	407	759	746	849	177	109	13.8
Finished manufactures.....	389	639	874	892	961	147	50	7.9

¹ Minus sign denotes decrease.

The increase in exports of finished manufactures as compared with 1927-28 was distributed among many individual commodities but was most conspicuous in articles made chiefly of metal. For the first time, the value of exports of automobiles (including parts and accessories) and of machinery both crossed the half-billion line, the former reaching \$591,000,000 and the latter \$563,000,000. Our foreign sales of automobiles showed the extraordinary relative gain of 39 per cent, while the increase for machinery was 21 per cent. Exports of the heavy products of iron and steel (part of which fall in the group of finished manufactures and part in semimanufactures) were nearly 26 per cent greater in value than the year before, and the increase in advanced articles of iron and steel was 19½ per cent. Other classes of finished manufactures showing very decided increases in value of exports include refined petroleum products, cotton manufactures, chemicals, paints and varnishes, tobacco manufactures, rubber manufactures, paper and manufactures thereof, and advanced wood manufactures.

The major commodity groups other than finished manufactures showed much less change in value of exports last year as compared with the year before. There was a considerable increase in the group of raw materials, of which cotton makes up much the greater part, and a smaller gain in exports of semimanufactures largely accounted for by the rise in the price of copper, exports of which

declined somewhat in quantity but advanced 11 per cent in value. Our foreign sales of foodstuffs fell off slightly as the result of a marked reduction in shipments of wheat and rye.

It is entirely natural that the export trade of the United States should show a markedly rising proportion of manufactured goods. This trend has been unbroken for several decades, although somewhat more conspicuous in the last few years. The class of finished manufactures represented 47.5 per cent of our total exports in 1928-29, as compared with 30.7 per cent in the immediate pre-war period. The growing share of manufactured commodities in our sales abroad is parallel with the growing part played by such articles in our domestic production and consumption, and in the production and consumption of the world as a whole. By the nature of things the per capita consumption of foodstuffs and of most other major farm products is limited and demand for them expands little if any faster than population grows. On the other hand, there is practically no limit to the demand for manufactured commodities, of one kind or another. Growing productivity in our own country as in other countries has taken chiefly the direction of adding to the supply of manufactured goods and of services which do not incorporate themselves in tangible commodities. Great as has been the recent increase in our foreign sales of manufactures, exports represent no larger a proportion of the output of our factories to-day than they did just before the World War, although the ratio is considerably higher than it was six or seven years ago. It is probable that the census of 1929 will disclose the fact that our exports of manufactures, other than foodstuffs, now represent substantially 10 per cent of the total production.

The great expansion of American exports of manufactured goods as compared with pre-war years has not been at the expense of foreign sales of American farm products. There has, of course, been a decline in our agricultural exports from the peak reached during and immediately after the war, when the output of European farms was greatly cut down and when shortage of shipping limited Europe's purchases of foodstuffs from markets more distant than North America. Nevertheless we are selling abroad to-day farm products to a value about 80 per cent greater than during the average year from 1910 to 1914, and even after eliminating the effect of price advances the gain is approximately 20 per cent. The United States has thus shown itself able to maintain, if not increase, its normal share of world trade in foodstuffs and other farm products even in the face of the marked agricultural development in such countries as Canada, Argentina, and Australia.

The changes in the geographic distribution of our export sales during the fiscal year just closed were for the most part in the same direction as those of other recent years. Exports to Europe increased by only 3 per cent, partly by reason of the actual decline in sales of grain to that continent, while to all the rest of the world we sold 16½ per cent more (in value) than in 1927-28. The continent showing the greatest increase was Asia, 20½ per cent, but to no great trade region outside of Europe was the increase less than about 11 per cent.

It is to be expected that, as manufactured goods become more important in our foreign sales, the gain in exports should be chiefly in trade with countries as yet little developed in manufacturing industries. Europe was formerly by far the largest buyer of American

exports, because at that time foodstuffs and raw materials were by far the major factors in our sales abroad. The proportion of our exports taken by Europe had gradually fallen for a long time before the war, but during the period 1910-1914 that Continent still took almost exactly five-eighths of the total, 62.3 per cent. In 1928-29 the proportion was four-ninths or 44.6 per cent. Whereas our sales to Europe during the last fiscal year were 78 per cent greater in value than during the average year immediately before the World War, our sales to the rest of the world have risen from \$816,000,000 to \$2,977,000,000, or by the remarkable ratio of 265 per cent. The gain has been notable in sales to all non-European continents and countries, but the greatest relative increase has been in exports to Asia, which took more than five and one-half times as much in value last year as before the war.

Apart from the marked price changes in certain leading articles already referred to, there were no very conspicuous new developments in the import trade of 1928-29. In terms of quantity, a large majority of the important items showed considerable increases as compared with the immediately preceding year, marked increases as compared with the low point of 1921-22, and still larger increases as compared with pre-war years. Noteworthy increases in terms of value during 1928-29 as compared with the year before appeared in foreign purchases of refined petroleum products, copper, vegetable oils, oilseeds, long-staple cotton, and art works. The class of raw materials as a whole showed a slight decrease in value of imports on account of the lower prices, while the class of finished manufactures showed a gain of nearly 8 per cent and that of semimanufactures a gain of nearly 14 per cent, the latter being especially affected by larger imports of semimanufactured copper.

Imports from Asia in 1928-29 on account of the decline in prices of rubber and tin, were only slightly greater than the year before, but from most of the continents our purchases increased by $3\frac{1}{2}$ to 7 per cent, and in the trade with Africa, which is still relatively small, the increase was nearly 16 per cent.

The United States has a larger share in both the export and import trade of the world at present than before the World War. The growth of our exports has not served, as some persons apparently suppose, to check the recovery of the industrial countries of western Europe from the demoralization caused by the World War. On the contrary, there is good reason to believe that the expansion of American export trade has actually helped the recovery of Europe. It has increased our own buying power for foreign goods, as is shown by the fact that our imports show a greater gain as compared with pre-war years than our exports. The Bureau of Foreign and Domestic Commerce has recently compiled the trade figures for a large number of foreign countries for 1927 as compared with 1913. The exports of these countries to the United States increased by 155 per cent in value during this interval, while their exports to all the rest of the world combined increased by only 46 per cent, most of this latter increase being due to the advance in price levels. The difference between these percentages of increase was more marked in the case of the exports of the countries under consideration than the difference in the case of imports. The purchases of these countries from the

United States rose 91 per cent in value between 1913 and 1927, while their imports from the rest of the world rose by 47 per cent.

Notwithstanding the fact that Europe exports chiefly manufactured goods of which the United States itself is a great exporter, the sales of European countries to us have increased more as compared with pre-war years than their sales to other parts of the world. Thus the five leading European participants in the World War, the United Kingdom, Belgium, France, Italy, and Germany, in 1927 sold goods to the United States to a value 50 per cent greater than in 1913, but their exports to other countries were only 27 per cent greater, the increase being less than the advance in commodity prices.

Moreover, the very great growth of the purchases of the United States from those countries, which produce chiefly foodstuffs and raw materials, has been of marked indirect advantage to the industrial countries of Europe. If one combines the exports statistics of a group of 10 countries comprising Argentina, China, British India, Ceylon, British Malaya, Netherland East Indies, Australia, New Zealand, Egypt, and the Union of South Africa, he will find that their sales to the United States in 1913 were valued at \$200,000,000, whereas in 1927 the total was almost \$900,000,000, or four and one-half times greater. Meantime their exports to the rest of the world (although still in the aggregate much larger than to the United States) had increased only 62½ per cent. This immense gain in their exports to the United States has benefited many European investors, who are interested in enterprises of production and transportation in these countries. Moreover, our purchases of such commodities as rubber, tin, silk, wool, hides and skins, varnish gums, semitropical fabrics, and oilseeds and oils have greatly increased the buying power of countries of this sort for manufactured goods from Europe as well as from America.

That the expansion of American exports has benefited Europe may be inferred from the fact that the recovery of European export trade has apparently aided our own producers and merchants to sell goods abroad. Broadly speaking, progress in trade is a mutual thing, and the gain of one nation means gains for others as well. At the close of the World War it was very commonly predicted that the recovery of European industry from the great slump caused by that catastrophe, and the turning of the attention of European factories from war requirements to foreign markets, would check the increase of exports from the United States. The contrary has actually happened. Europe is steadily recovering in production and trade, and exported goods in 1928 to a value 47 per cent greater than in 1922, yet our own exports have increased by not far from the same proportion, and our exports of manufactured goods, which must compete with the European products, have increased much more. Europe itself has taken more and more of our manufactured goods, while the fact that Europe is a better market than before for foodstuffs and raw materials produced in Asia, Africa, Latin America, and elsewhere has added to the buying power of those regions for our own manufactures as well as for those of our European competitors. Above all has the recovery of the European manufacturing industry been an advantage to American agriculture, enabling us to keep up

large sales of grain, pork, cotton, and other farm products to that continent, notwithstanding that Europe's own fields are now producing much more than during and immediately after the World War.

The truth is that, so long as peace is maintained among the nations, the total productive capacity of the world expands greatly and trade between the nations expands even more rapidly. Moreover, as trade expands, the proportion of it consisting of advanced commodities becomes constantly higher. For decades before the World War the trade of practically every country of the world was steadily advancing. There was then, as there is now, vigorous competition for foreign outlets, especially in the case of manufactured goods, but this competition did not prevent the expansion of the exports of every industrial country. Those factors which were at work prior to the World War to build up productive capacity, raise living standards, and expand international trade are again in evidence throughout the world.

ELIMINATION OF WASTE

[A résumé of the department's contribution compiled by RAY M. HUDSON, Assistant Director, Bureau of Standards]

At no time since the inception of the movement in 1921 has the elimination of waste received so much attention as during the past 12 months.

In production and distribution—that is, manufacturing and merchandising; in construction, mining, land and marine transportation; in the field of finance; and in many other forms of human enterprise, there is evidence of increased understanding of waste and greater appreciation of the “huge deduction it makes from the total goods and services which, but for waste, we might all enjoy.”

Through the report of the Hoover Committee on Waste in Industry, issued in 1921, the attention of management in many lines of business was focused on the opportunities before it to strengthen and stabilize business through voluntary cooperation for the elimination of waste.

Consequent effort to apply the recommendations embodied in this report has yielded many direct and also indirect benefits to manufacturers, distributors, and consumers. As these results have become more widely known, both business and public interest has increased, until to-day waste elimination is accepted as a fundamental of modern business management. In fact, the pressure of current interindustry competition is causing management generally to look for to-morrow's profits in to-day's wastes.

Because of this larger recognition of waste, and the growing appreciation of the values in its elimination, the Department of Commerce is constantly called upon by industry and business for cooperation in endeavors designed to reduce wastes of material, time, human effort, and human life.

The contribution of these cooperative efforts to business stability, national wealth, well-being, and prosperity can not be measured precisely, but the following review of the interests and activities of the several branches of the department shows how they are helping to reduce waste.

Gratifying as the results to date may be, the surface of avoidable waste has been barely scratched. The potentialities for further contribution through continued cooperation are tremendous, and it may be confidently expected that still greater results will be forthcoming as the losses and penalties of needless waste become more widely known.

SIMPLIFIED PRACTICE

For the past eight years, the division of simplified practice, serving as a coordinating agency for manufacturers, distributors, and consumers seeking to minimize the wastes resulting from excessive diversity in size, dimension, etc., of commonly used commodities, has

helped to bring about 111 simplified practice recommendations; 12 of these were completed this fiscal year.

This record demonstrates not only the nation-wide interest in simplification as a fundamental of good management, and a new way to better net profits, but it also shows that maximum benefits from waste elimination are attainable only through concerted action of entire industries and close cooperation between all interests. It further serves to emphasize the interdependence of all industries, and the necessity for more effective coordination of effort as a basis of improved national well-being.

In recent years the high wage level and the relatively stationary cost of living have given to many a larger margin between income and outgo. This has increased the number and variety of consumer wants, while keen competition for a larger share of the consumer dollar has stimulated many manufacturers and merchants to diversify lines, revamp or redesign products, and to develop new ones. In well-established lines the simplification process goes on continuously, items being eliminated, while in the midst of effort to improve old goods or develop new. Persistence in pruning out the least desirable and adding the better is but a natural part of progress.

The continued success of simplified practice is evident in the high sustained average of adherence accorded simplifications now in effect. Eighty-six per cent of the output in 27 recommendations reviewed this fiscal year, as revealed by statistical reports from the participating manufacturers, conformed to the sizes, dimensions, etc., of their respective simplified practice programs.

The average of the yearly adherence figures for the last eight years is 83 per cent.

AMERICAN MARINE STANDARDS COMMITTEE

This committee is representative of the marine industry. It operates with the division of simplified practice, aided by the United States Shipping Board. As of June 30, its membership comprised 356 member bodies, and it had promulgated 102 standards covering construction, machinery, equipment, and operation of ships. A technical committee on port facilities was recently organized in cooperation with the American Association of Port Authorities.

COMMERCIAL STANDARDS

Any analysis of our present economic situation is bound to reveal certain facts and obvious trends in the commerce of to-day. More time and energy are being devoted to careful and judicious expenditure. There is more shopping around for better values and better bargains among the professional purchasing agents, who contract for the materials used and fabricated by our large industrial organizations and institutions. With increased travel and speedier means of communication our people are becoming better judges of value and are demanding higher quality. Every known article possessing outstanding or unusual quality is enjoying a large and highly profitable business.

In the present perplexing market of novelties and color the consumer buyers, and even the professional purchasing agents, are

finding it increasingly difficult to distinguish between items of real merit and products built "for appearance only." It is natural, therefore, that the buyer and the purchasing agent are both seeking authoritative and dependable criteria of quality, such as commercial standards, and are welcoming certificates from reputable producers that the quality of the goods equals or exceeds the commercial standard specification.

Among the producers competition was never keener than to-day. The alert trade association seeks a means of assuring the buyer and the professional purchasing agent alike of the inherent quality of the proffered goods. Individual trade-marks and trade-association labels are helpful but are not always sufficient to satisfy the skepticism of the modern purchaser, who demands to be shown with laboratory analyses and tests, sponsored by an unbiased and unquestioned authority, the quality of goods delivered.

The commercial standard, developed and established by industry itself under the observation of the Federal Government; accepted in writing by producers, distributors, and consumers alike; printed and promulgated by the Department of Commerce after the most severe scrutiny, satisfies all of the ramifications of the situation and offers an authoritative and dependable basis for marketing and purchase by all elements directly concerned.

The division of trade standards actively assisted on 34 projects requested by industries interested in establishing commercial standards. During the year 15 of these projects passed the general-conference stage, being adopted by the industries concerned. To and including June 30, 1929, six projects were accepted in writing by a majority representing over 65 per cent of the volume of production of each commodity. Six are now issued in printed form. With but a single exception the remainder are in process of obtaining written acceptance.

Among the commercial standards officially accepted by industry are: Staple porcelain (all-clay) plumbing fixtures, which cover grading rules, nomenclature, definitions, over-all measurements, and standard roughing-in dimensions for porcelain kitchen sinks, laundry trays, slop sinks, stall urinals, lavatories, baths, and shower receptors; regain of mercerized cotton yarns, being a basis for weight adjustment between buyer and seller; domestic and industrial fuel oils, comprising complete specifications for distillation range, viscosity, flash point, etc., of six grades of fuel oils; dress patterns, which constitute a definite uniform basis for selection of proper type and size of dress patterns, as well as standard widths of cotton, wool, and silk material for pattern layouts; wall paper covering a minimum specification for color fastness, paper stock, and other quality criteria for wall paper; and diamond-core drill fittings comprising standard threads, joint dimensions, and tolerances to provide complete interchangeability of these fittings as produced by various manufacturers, as well as standard terminology and symbols to prevent confusion of sizes and types.

With the cooperation of the Bureau of Foreign and Domestic Commerce arrangements have been made whereby commercial standards accepted by American industries may be translated into foreign languages and such translations distributed through our foreign trade representatives as an additional means of promoting foreign trade in these commodities.

CERTIFICATION AND LABELING

In order to broaden the field of supply of commodities covered by Federal specifications, it is the duty of the Federal agencies to make and keep these specifications in harmony with good commercial practice. From time to time the State and other public purchasing agencies have sought the assistance of the Department of Commerce in the formulation of standards, specifications, and methods of tests for their purchases. As a solution to these several problems the so-called certification plan is being applied to certain selected Federal specifications in such a way as to make it as effective as possible for "public purchasers"; that is, for the governmental and institutional agencies, Federal, State, county, and municipal, who are spending the money collected from the public in the form of taxes.

In accordance with this plan, there have been compiled by the National Bureau of Standards lists of such firms as have expressed to the bureau their desire to have their names placed on the lists of manufacturers willing, when requested to do so, to certify to purchasers that material supplied in accordance with the designated 267 Federal specifications complies with the requirements and tests of these specifications, and is so guaranteed by them. These lists represent more than 7,500 requests for listing from over 2,000 firms.

The groups of commodities covered by the specifications to which the certification plan has been applied, the number of Federal specifications in each group, the number of requests for listing, and the number of firms requesting listing in each group, are shown in the accompanying table.

Commodity groups	Specifi- cations	Listings	Firms
Abrasives and polishing materials.....	9	108	50
Brushes and brooms.....	48	944	168
Builders' hardware.....	1	33	33
Cement, Portland.....	1	68	68
Electrical supplies.....	11	176	139
Fire extinguishers and liquids.....	3	78	49
Glass.....	1	59	59
Heat insulating materials.....	8	58	30
Inks.....	7	126	47
Leather goods.....	4	106	78
Lime and plaster.....	4	149	86
Linoleum.....	2	10	5
Liquid-measuring devices.....	1	21	21
Packing and gaskets.....	13	162	70
Padlocks.....	1	17	17
Paints and paint materials.....	30	3,004	305
Paper.....	29	459	96
Pipe and pipe fittings.....	7	86	60
Refractories.....	3	107	57
Ribbons, typewriter.....	3	94	36
Road and paving materials.....	7	123	45
Roofing, bituminous, and waterproofing.....	16	571	105
Rope wire.....	1	15	15
Safes, burglar-resisting.....	1	3	3
Scales, railroad track.....	1	7	7
Screws, wood.....	1	13	13
Soaps and scouring compounds.....	13	563	149
Tableware, silver-plated.....	1	7	7
Textiles.....	36	598	207
Tubing, metallic.....	4	61	49
Total.....	267	7,826	2,074

The certification plan has also been applied to seven commercial standards, 88 firms having expressed their desire for 107 listings among the willing-to-certify manufacturers of the commodities covered by

commercial standards for clinical thermometers; Stoddard solvent; all-clay plumbing fixtures; brass, steel, and wrought-iron pipe nipples; and regain of mercerized cotton yarns.

Commercial standards are set up by industry itself as the basis of trade throughout the industry as a whole, including producers, distributors, and consumers, both contract and over the counter, and the manufacturers, dealers, and users are asked to limit their transactions to these lines of commodities so far as they can conveniently do so. The certification plan is applied to commercial standards only when specifically requested by the representative conference and definitely agreed to by the manufacturers.

In certain instances, the manufacturers are using self-identifying labels to set forth their guaranty of the quality of certain of their goods as being in compliance with the requirements of designated nationally recognized specifications or commercial standards. Certain manufacturers have stated that they are now using or planning to use quality-guaranteeing labels, or their equivalent, with goods manufactured to comply with Federal specifications for dental alloys, dry cells, fireproof safes, gypsum, ink, linoleum, lumber, paint, pipe, Portland cement, soap, and textiles.

SCIENTIFIC RESEARCH

Bureau of Standards.—Waste is vast potential wealth. Research discloses its nature and measures its properties. To match these with some need of industry is most profitable. After confirmatory tests in the laboratory and in service, the discovery enters industry, ever adding wealth to the Nation long after the research is forgotten.

Cellulose sulphite, a waste from pulp mills polluting streams and killing fish, was by research found useful for tanning leather, replacing costly chestnut wood which the blight was exterminating. Bureau research proved that leather so tanned was satisfactory in quality, and Federal specifications were amended to permit its use in the leather industry.

When the corrosion of duralumin threatened its use in aircraft where its lightness made it most valuable, the bureau on request developed a protection. Its experts proposed a coating of pure aluminum and studied specimens so prepared. Even when its coating was attacked the coated duralumin was found more durable than duralumin alone. Specimens withstood 100,000,000 alternations of stress in bureau tests. The coated duralumin is now being produced commercially. Longer life was thus assured a valuable but corrodible alloy most useful in aircraft, minimizing waste by lessening the necessity for renewals of aircraft parts.

Unmeasured waste from defective materials built into structures has stimulated testing in advance of use to prevent weakness or short life. Testing materials is effective in eliminating such waste. In this the bureau has just cooperated by publishing a directory of nearly 600 testing laboratories and by establishing jointly with other groups a cement testing reference laboratory where cement-testing methods may be tried out, equipment standardized, and testing staff instructed for service in the cement laboratories of the country.

"Winter damage" was until recently a mysterious source of loss through injury to clothing and other textiles laundered in winter. On request of the industry, a bureau research was authorized for

finding the cause and the cure. Both were found. As an example of the elimination of preventable waste it is most interesting. All "winter damaged" garments were found to have been washed and dried out of doors and were also found to contain sulphuric acid. Atmospheric sulphur dioxide from winter fires was suspected at once as the cause. Damp towels exposed to a laboratory atmosphere containing a millionth part sulphur dioxide showed damage similar to the "winter damage." It was also found that the chemical reaction was increased notably by the heat applied in ironing. The simple remedy recommended—introducing calcium bicarbonate in the final rinse water to neutralize the acid—has been tried with success by a number of commercial laundries, materially reducing the loss.

To prolong the useful life of materials is a most valuable type of research for the elimination of waste through frequent replacement. In a research on leather, chromium tanning followed by vegetable tanning was found to add 50 per cent or more to the life of sole leather. Another research on the life of paper showed that the processing of the fiber is the greatest factor in its deterioration, and suitable control of such processing a fruitful means of adding to its service life. Accelerated aging tests for paper have been devised and are now in use.

The natural weathering of paints is so slow that for laboratory research accelerated tests were devised to duplicate damage from alternating rain and ultra-violet radiation, altogether speeding up tenfold the weathering tests and the selection of the more weather-resistant specimens. For other materials alternating freezing and thawing is the factor of damage. These are accelerated in the laboratory by artificially speeding up the cycles of freezing and thawing. Research is in progress on testing the bond between brick and mortar, measuring the bond strength initially and after 50 cycles of freezing and thawing. Some samples of slate resist 4,000 freezings, indicating high resistance to frost action. Cast stone from all parts of the United States was subjected to alternating freezing and thawing and found to vary greatly, some cast stone enduring 500 cycles, while others showed signs of disintegration after 15 cycles.

The importance of research in prolonging the life of materials is evident from the recent disclosure that certain building stones supposedly of long life have decayed within 60 years. Means are being sought to prolong the life of stone by suitable protection procedure. Crazeing of semiporcelain was found by research to follow absorption of water and expansion of the body. Cracking of the glaze resulted. Recommendations were also published on desirable properties in clays which will increase the life of fire brick. Methods were devised also to enable terra-cotta makers to test the weathering quality of their ware before it leaves the factory, thus saving the waste in shipping defective material.

Another type of waste elimination by research is exemplified in the technique worked out to avoid spoilage of enameled ware by blistering. Briefly, light-colored vitreous first coats may be applied to metal, forming oxides of the metal and of cobalt which serve as an adhesive surface. The blistering was found to be caused by the carbon dioxide and monoxide formed at the surface of the metal. By suitable treatment of the surface layer it was found to be possible to control the enameling to avoid spoilage.

A first step in finding uses for waste materials is analysis. No system of analysis of the waste ends of levulose-bearing materials was known. The bureau therefore devised suitable analytical methods, the first fruit of which is the discovery and extraction of a new sugar—difructose anhydride—from such waste.

Utilization of waste materials by finding experimentally products in which they can be used may be illustrated by several examples of recent developments in connection with the bureau's cooperation on the saving of farm wastes. A strong brown paper was made from artichoke tops, roofing felt from sawdust and waste paper, and a new kind of sugar—xylose—from cottonseed hulls, peanut shells, and corncobs. This sugar is now being manufactured commercially. Cornstalks were made into three new materials: A hard rubberlike material, a lumber substitute, and insulating board of double the strength of any commercial board.

In search of a cheaper substitute for costly platinum in technical work, alloys of rhodium were produced and made into electric furnace windings for experimental study and showing up well in service.

In the conservation of heating and cooling effects so important in homes, offices, and factories and in the refrigeration industries, the bureau has contributed research results on the measured values of the insulating quality of insulating materials. These data will facilitate the selection of the most suitable materials for insulating homes and other structures.

The bureau has in progress several hundred researches. A great number of these have directly a bearing on the problem of waste elimination. In seeking dependable minima of dimension in the design of products and structures, the researches on the properties of materials are of direct application. The enhanced utility of devices resulting from better fits, more accurate dimensioning, are notable. These are secured dependably through research on the effect of improved accuracy. In other words, the application of measurements to industrial problems can not fail to reduce the waste by basing design on better numerical data and testing the parts and built-up machines by systems of precision gages. The theory is that there is a presumptively best dimension of product or part and a best magnitude of any useful property or characteristic which gives the least waste. The bureau's researches are designed to develop the best measured controls in the processes being studied or developed, so that waste may be minimized and efficiencies promoted. Not the least useful function is to conserve industrial effort by assigning the right degree of accuracy which a given case deserves, for at the "good enough" point waste begins.

UTILIZATION AND CONSERVATION OF NATURAL RESOURCES

Mineral.—The study of problems of efficiency in the use of fuels, in which the Bureau of Mines has been a pioneer, has resulted in great savings to industry. This work includes the analysis of thousands of coal samples from the various producing districts, the improvement of combustion methods, the utilization of low-grade fuels, the study of new types of fuel, the preparation of coal, and the carbonization of coal with attendant conservation of by-products. The bureau has conducted tests of all representative coals to determine

their heating, steaming, and gas-producing qualities. Attention has been given to new materials and new methods in the manufacture of illuminating gas and to the obtaining of more and better by-products in the coking of coal. The results of this extensive program of investigation have been made public in numerous bulletins, which afford helpful information to the coal operator, the coal marketer, and the coal consumer. As the result of the bureau's fuel economy service, many thousands of dollars are being saved annually through the use of better equipment and improved combustion methods in Government heating and power plants.

Substantial increases in the production of marketable fuel in Alabama and the Northwestern States are being obtained as the result of investigations in the washing of coals. Studies of the conditions in boiler furnaces and their effects on the life of boiler settings have resulted in the obtaining of information which should tend to avoid the rapid deterioration of boiler furnace refractories.

The bureau's studies in the field of metallurgy have contributed largely to the annual recovery of millions of dollars worth of metals from complex or low-grade ores that formerly could not be worked profitably. Metal losses in milling that once reached several millions annually have in later years been greatly reduced. Through its investigative work, the bureau seeks constantly to focus attention upon wasteful or inefficient practices, to point out improvements, and to obtain the cooperation of producers in adopting better methods and bringing into use more efficient devices.

A major activity during the past year has been the development of methods which can be successfully applied to the production of manganese, essential in the manufacture of steel, from low-grade domestic deposits heretofore undeveloped. A study of lead blast-furnace practice is affording data which should lead to improved practice and increased efficiency in the important lead-smelting industry. The bureau's studies in the physical chemistry of steel making are supplying information which should eliminate unscientific and wasteful methods hitherto employed. Microscopic studies conducted during the year have continued to locate the causes for extensive tailing losses of metal where other methods of identification have failed. A study of methods of developing lead-carbonate ores in many western mining districts which are of too low a grade to be economically mined has been successfully conducted. A method for agglomerating slime and fine particles in leaching ores developed by the bureau promises to have wide application in the recovery of the copper in the enormous tonnages of tailings carrying small percentages of metal which have accumulated at copper concentrators in the Southwestern States.

Studies in the flotation of ores have assisted materially in the successful application of this method to many classes of ores not heretofore amenable to such treatment. Investigations in the milling of lead and zinc ores have been instrumental in the attaining of very large savings in the Missouri-Kansas-Oklahoma district, where milling losses have amounted to millions of dollars annually.

Research was continued looking to the elimination of wastes in the mining, treatment, and utilization of the numerous important non-metallic minerals, which are widely used in the construction of build-

ings, highways, and engineering projects. Studies relating to the more efficient production of phosphate, bauxite, and kaolin, and to the utilization of the Nation's extensive ocher deposits were conducted.

The bureau is assisting the petroleum industry in the development of methods of production whereby more than 20 per cent of oil in underground deposits can be recovered, and in the devising of processes by which larger percentages of motor fuels and other commercial products may be obtained in the refining of petroleum. By conducting special engineering studies of important oil-producing fields, the bureau is assisting operators in their efforts to control underground water which threatens continuance of successful development. The bureau's studies have assisted materially in reducing evaporation losses of petroleum from transportation and storage which have run into millions of dollars annually. A special study of the salvaging of material and equipment used in the petroleum industry has pointed the way to the elimination of wastes which annually reach enormous figures. A study of the controlling and gauging of natural gas wells has afforded information which should prevent the waste of millions of cubic feet of gas annually lost in conducting open-flow tests.

The development of the new helium production plant near Amarillo, Tex., has resulted in the conservation of the largest helium-bearing natural gas field known and in the assurance of ample supplies of this rare noninflammable gas required by the Army and Navy for the operation of dirigibles. Continued operation of the plant for a period of several months indicates that the cost of helium to the Government will be cut in half.

The special study of mining and milling methods and costs at representative operations in the various metal and coal mining districts of the country is assisting operators materially in the attainment of more efficient methods and the lessening of costs. These studies include such matters as prospecting and exploration, drilling and blasting, the loading of ores and coal, mine timbering, the breaking and handling of ore, mine ventilation, underground transportation, and mine sampling.

Products of the soil.—There are more than 100,000,000 tons of cornstalks produced in the United States annually. A small proportion of them is used for cattle food, but most of them are either plowed under or burned. It is now generally believed that in corn-belt soils the value of the cornstalk as a fertilizer hardly pays the expense of plowing them under. Burning the stalks is likewise expensive, and is resorted to only as a method of removing the stalks in a way which will stop the further progress of the corn borer.

In cooperation with Iowa State College, our Bureau of Standards has built and is now operating a semicommercial factory at Ames, Iowa, to make board of cornstalks. Thus far it has demonstrated that an insulating board of satisfactory quality can be made of cornstalks. It has ascertained, by experiment, the best type of equipment to be used for the purpose. An economic study of the markets for the board has been completed. In short, the bureau has demonstrated as far as can be done on a semicommercial scale that the manufacture of insulating board offers an outlet for some of the now

wasted cornstalks at a reasonable profit to the farmer, the manufacturer, and the public. The first commercial factory, built by private capital, is now operating.

The station at Ames is being used to develop similar information about the manufacture of pressed board. This board may be acceptable as a substitute for lumber for certain purposes, and may thus afford an outlet for more cornstalks.

About a million tons of cottonseed hulls are available annually. After the shortest cotton fibers are removed from the seed and sold as linters, the seeds are cracked and the kernels taken out. These kernels are valuable as the source of cottonseed oil and press cake. The hulls are of doubtful value and have only a precarious market.

The bureau has found that these hulls contained about 24 per cent of xylose. It has also found a means of extracting this xylose from the hulls, and in cooperation with Alabama Polytechnic Institute, University of Alabama, and the Federal Phosphorus Co., it has built and is now operating at Anniston, Ala., a semicommercial xylose factory. Information on the type of equipment needed for the purpose and on the cost of manufacture is being obtained.

Xylose is a sugar, but is radically different from any sugar ever before on the market. Its suitability as a food for men and animals is being investigated by several public and private laboratories. Its possible use as a raw material for the manufacture of explosives, lacquers, acids, and many other things, is being developed by several cooperating investigators, all using samples furnished by the factory.

If any of these numerous studies turn out successfully, there will be a market for xylose, and therefore a market for some of the cottonseed hulls now being wasted.

Xylose can also be made from peanut hulls, of which there are about 45,000 tons a year available.

After the xylose has been extracted, the residue is mostly cellulose. This may have some commercial value not now known.

Straw, in the big grain-producing areas, is largely burned on the field in order to get rid of it. Paper has been made from straw, but the quality was too poor and the cost too high to be economical. It is possible to improve the quality. Modern harvesting equipment and motor transport have reduced the cost. Perhaps, under present conditions, straw paper is economical. Work on this has just been started; the pulp being made at Ames, and the paper mill at the bureau used for making the paper.

Wood utilization.—The principal achievements of the National Committee on Wood Utilization for the past year include the following:

- (1) The completion of a publication, *Wood Construction*, which is in reality a handbook on the use of wood for construction purposes. The book discusses such subjects as the properties of wood as a building material; principal species and their identification, grading, and specifications; their preservation and protection; and their application in temporary, light, and heavy construction. A special control committee of nationally known architects, engineers, and builders guided the preparation of this book.

- (2) Cooperation in efforts looking toward the reduction of economic losses arising from the use of lumber insufficiently or improperly seasoned. The committee's part in this program has included the

preparation and distribution of four bulletins, one for consumers, one for distributors, one for fabricators, and a fourth for manufacturers of lumber, on the general subject Seasoning, Handling, and Care of Lumber. These bulletins summarize for each of the groups indicated the best methods of reducing seasoning and handling losses.

(3) Further promotion of the system of grade-marking lumber. A systematic drive was made during the year in cooperation with trade and professional associations to direct the attention of lumber buyers to the protection afforded them in specifying grade-marked lumber in their purchases.

(4) Continuation of activities to acquaint the public and the lumber industry with the economies possible through the use of short-length lumber. A publication on the subject has already had a wide distribution.

(5) Extension of use of end-matched softwoods as a means of reducing waste and securing greater economy in building.

(6) Promotion of the manufacture of small-dimension lumber at the mill instead of at points of consumption with a view to eliminating freight charges and the waste involved in cutting stock to dimension on the job. Information on this subject is now available in a bulletin published by the committee.

(7) Reduction in the waste of wood by finding uses for discarded materials either through direct manufacture or working the materials for valuable by-products. An example of the first method of reducing waste is the plan developed by the committee for making useful and interesting articles out of second-hand boxes and crates and odd pieces of lumber. The first of a series of bulletins under the title "You Can Make It," containing over 100 suggestions for utilizing discarded wooden containers, was issued by the committee during the past year. The committee is attempting to reduce the present waste of wood at sawmills, planing mills, and woodworking plants. To that end surveys were made in two States. In Virginia 28,000 carloads and in North Carolina 32,000 carloads of such wood waste suitable as raw material for pulp mills, fiber factories, box plants, and similar industries were found. The survey is now being extended to the State of Maryland.

(8) Tests sponsored by the committee which show conclusively that a gang saw will cut profitably small logs which heretofore could not be cut at the sawmill, thus making possible the use of a greater portion of the tree. This applies particularly to west coast timber.

(9) Reduction of losses caused by stain and mold in lumber. As part of its effort in this field the committee has published a manual on the proper treatment of lumber to prevent sap stain.

Fisheries.—The Bureau of Fisheries' efforts toward a further reduction of waste lie in the fields of biology, fish culture, and fisheries technology and include the following:

(1) Development of the science of water farming—(a) to utilize waste water areas for food production under controlled conditions, developing means for producing a maximum yield; (b) to control natural waterways in such manner as to increase their productivity; (c) to grow larger percentages of hatchery-produced fish to maturity, through curtailing the ravages of diseases and growing the fish to a larger size before releasing them in the natural streams; (d) through

selective breeding to produce superior strains of brood stock of rapid growth, yielding a larger number of eggs and possessing disease-resistant qualities; and (e) development of fish screens to prevent losses of fish in irrigation ditches.

(2) Encouraging the States to enact such legislation as will prevent the heavy destruction of immature and undersized fish; to save the spawn for the hatcheries; to outlaw unusually destructive fishing practices and to so administer their fishery resources as to yield the highest possible return without endangering the future supply.

(3) Technological research to improve methods of manufacture of fish and shellfish meals for stock feed; solve the problem of reduction of fish waste rich in glue; develop improved methods for saving cod livers for production of medicinal oil; continue experiments in net preservation to lengthen the life of the fisherman's gear; and develop improved methods of preparing fresh fish for market for shipment to points distant from centers of production.

(4) Effect improved methods of unloading fish from fishing vessels to provide more expeditious handling without damage to the product.

STATISTICS

The last few years have been marked by a period of generally sustained prosperity, little short of spectacular. During the years following the postwar depression, there have been none of the violent fluctuations in business such as have characterized most of our previous periods of high activity. This has in a very large measure been due to greater knowledge and wider use of the current facts on industry and commerce.

This growth in the utilization of statistics is manifest in all fields of production and distribution and has provided business executives with a basis for combating industrial and commercial wastes, which until recently could be directly attributed to the lack of facts in the establishment of production and merchandising policies.

With the growing complexity of business and the rising interdependence between one industry and another, the business executive must not only know how his own firm is progressing but also how his industry and business and industry generally are progressing; he must know the buying conditions of his customers as well as the conditions within his raw-material markets; he must know of conditions surrounding the credit structure and of the employment conditions within his potential market and how these and a thousand other factors may affect the welfare of his own business. In short, he can not know too much if he will effectively withstand the hazards which rapidly changing conditions are bringing forward.

The files of this department disclose many interesting applications of business statistics and the results which their utilization have accomplished. A building-supply company in negotiating for its yearly contract for cement was urged to make a quick purchase before the development of a shortage. A study of business statistics as presented in the Survey of Current Business indicated to that company that cement stocks were 1,500,000 barrels higher than the year before and that prices actually seemed to be on the decline. Further examination disclosed to executives of that company that 300,000 freight cars were reported as being idle, as against a shortage

of 68,000 the year before, indicating that the railroads could be counted upon to deliver merchandise promptly. The use of these facts, according to the purchasing agent, enabled the building-supply company to save 30 cents a barrel on a large order of cement.

Not long ago a request was received from a large manufacturer of women's wear substantially as follows: "I am contemplating adding a line of manufacture appropriate for use by owners of rumble-seat cars. I would like to get information, if possible, as to the number of such cars manufactured and sold during each year." From a manufacturing and marketing viewpoint, the question of this manufacturer provides a striking piece of evidence of the rise of factual thirst on the part of American industry in its endeavor to eliminate waste in the production and distributive processes.

AIDS TO BUSINESS

The domestic-commerce division is engaged in a number of research projects whose results are aimed at the elimination of some portion of the estimated \$8,000,000,000 wastes in the distribution system. Waste, for instance, that arises from such conditions as excessive expenditure in sales promotive efforts without adequate information as to prospects in a given market; disorderly marketing; haphazard procedure in retail merchandising; extravagant delivery services; and unwise credit methods.

Regional surveys.—The most sweeping endeavor of the division is its national regional market surveys, in connection with which the United States has been divided into nine regions, for detailed analysis of local commercial factors. These surveys are to provide a thorough basis of facts upon which scientific, wasteless distribution may be planned.

The reports on each area describe the outstanding features of the fundamental industries of agriculture, forestry, mining, fishing, manufacture, trade, etc., which form the sources of people's income and wealth. Commodity movements and the machinery of distribution, wholesale and retail marketing areas, merchandising and credit trends, factors involving advertising appeal, store and plant location, nature of outlet, merchandising methods, buying habits, commodity preferences, and other factors are considered.

The Commercial Survey of the Southeast and one of three volumes comprising the New England Survey have been printed. The Pacific Southwest Survey is ready for printing and field work on the Gulf Southwest Survey has been started.

Distribution cost analysis.—Another type of waste-eliminating research in which the domestic commerce division is engaged concerns the analysis of distribution costs from the standpoint of the cost of handling individual items or performing individual services. The investigations into wholesale and retail distribution, for several lines of trade including groceries, hardware, dry goods, paints and varnishes, electrical equipment and specialties, have as their purpose not so much to provide comparative data on operating costs or to specify wasteful practices in the concerns studied, but rather to present a method for functional cost allocation, which may easily be adopted by any member of the trade in determining the profitableness of his own individual commodities, customers, or services.

Our wholesale hardware study records the experience of a firm which had reduced its inventory items from 12,000 to 6,500; customer

accounts were cut about 50 per cent to include only those which were profitable; the sales territory was reduced about 35 per cent, and yet the dollar volume of net profit was increased 35 per cent, and operating expenses were reduced from 20 per cent on sales volume to 16 per cent.

Retail credit survey.—Still another line of research designed to eliminate wasteful procedure from distribution concerns the matter of credit selling. Of the immense sum of not less than \$8,000,000,000 estimated to represent waste in distribution, nearly \$1,000,000,000 is said to be attributable to credit losses. In view of the desirability of scrutinizing credit practices to eliminate preventable waste, the domestic commerce division has undertaken, at the request and with the cooperation of the National Retail Credit Association and affiliated business groups, a national survey of retail credit conditions.

A material part of the costs of distribution is said to come from cost of extending credit. Any unnecessary mark up in consumers' prices caused by charges to cover wasteful practices in the extension of credit is a burden on all classes of business, as well as on the consumer, and anything that will help to reduce the cost of extending retail credit will be a boon, therefore, to consumers, retailers, wholesalers, manufacturers, and farmers.

The survey will show, for instance, by number, size, location, and class of store—department, chain, automobile, furniture, shoe, clothing, grocery, hardware, etc.—the losses on open accounts and on installment sales, collection ratios, and methods of credit scrutiny, correlations between credit losses and proportion of price represented as down payment, in different lines of business, repossessions, and salvage values of individual commodities.

Industry surveys.—The domestic commerce division is also engaged in studying the relation between the condition of productive equipment and profits. The replacement of machinery which, in point of service may have many years of usefulness but which is incapable of satisfying the latest fancies of the consumer market or competing with more recent and improved machinery, has been a difficult point for manufacturers and has prompted requests for a study of this problem.

The important phases of the industrial equipment studies are: (1) To bring out facts showing the relation of equipment obsolescence to production costs, and (2) to discover, if possible, a means for correctly evaluating and providing for obsolescence in costs accounting. The first result is expected to be obtained by the study of machinery among manufacturers of the same. The second result is expected from an investigation among the users of such machinery.

In addition to this type of industrial survey, the division is making related studies designed to show the correlation between production, sales, and stock on hand of various industrial products, and to reveal past and present trends in consumption of particular sizes for which there is a demand. An opportunity for simplification of products was suggested in the ensilage cutter machinery study by the fact that 5 of 17 sizes accounted for 80 per cent of the total sales of the concerns surveyed.

These two types of industrial survey, it is hoped, will enable the elimination of wasteful practices with respect to equipment purchase and replacement, and by pointing the way to coordination of productive capacity and output with market demand.

Marketing areas.—Among still other projects of the domestic commerce division are studies designed to outline logical trading areas throughout the United States and providing basic market data upon which sales or advertising quotas may be set by any concern, scientifically and with a minimum of guesswork.

As a summary to the entire field of market research, the division publishes annually a volume entitled "Market Research Agencies," which lists all known research organizations in the United States and describes their activities and available studies. One obvious result is that much duplication of research effort is thus avoided.

TRANSPORTATION AND TRAFFIC MANAGEMENT

Gratifying results continue to be shown in the elimination of waste in physical distribution of goods. Cooperative efforts along these lines among manufacturers, shippers, carriers, warehousemen, consumer bodies, and Government agencies, continue to effect substantial saving in the physical movement of merchandise. Studies inaugurated last year, which include close scrutiny of each distinct phase of material handling from point of production of raw material to place of consumption of finished product while yet in initial stages, clearly show that enormous wastes can be eliminated by modernizing handling and packing methods.

The joint program of the division of simplified practice and the transportation division which followed the adoption of standard dimensions and heights of lift trucks and skids, has already made itself felt in the field of industry. As a result, many manufacturers and shippers have found use for skid trucks, tractors, and trailers in handling merchandise, and reports point to appreciable savings in handling operations.

The adoption of the use of skids and trucks at railway terminals and in coastal and intercoastal shipping, and the adoption of standard dimensions to permit interchangeability, has already tended to extend the use of such equipment for the handling of merchandise into new fields.

Other recent developments in material handling and shipping goods are pointing the way to further possible opportunities in waste elimination. It is claimed that the unit-container service, installed by several eastern railways, has already demonstrated results from the use of such equipment. Further benefits along this line are anticipated; there appears a necessity for standardization of such containers for use on standard flat or gondola cars. At the present time unit containers are designed for handling by special equipment, and are not permitted off the lines to which they are leased.

The use of container cars for less than carload and package freight has extended the activities of freight forwarding companies. These organizations, which have developed their own station facilities, collect small shipments and forward in package cars, or unit containers, to destination, where similar service is performed in delivery. The shipper's advantage derived from such services is pointed out to be usually lower packing costs, pick-up, and delivery, and a minimizing of damages to goods in transit. The forwarder usually satisfies himself with the profit arising from the difference in the less-than-carload costs the shipper would be required to pay when forwarding small shipments and the carload rate he obtains on such consignments.

INDUSTRIAL TRAFFIC MANAGEMENT

While it has been evident for a long time past that there were great possibilities for the elimination of waste in transportation from the shipper's viewpoint, the findings of the survey on industrial traffic management conducted during the past year by the transportation division of the Bureau of Foreign and Domestic Commerce reveals figures of waste eliminations which far exceed the expectations of those interested in inaugurating the survey.

This work was undertaken at the request of the associated traffic clubs, and after a year's study the transportation division is summarizing the conclusions for publication; 1,500 complete questionnaires returned by all types and forms of business establishments have supplied all the material which will enter into publication. Information will be shown concerning the proper cost of such a department, and the functions required of its personnel.

The survey discloses that business organizations in many cases have eliminated losses from \$4,000 for small concerns to \$350,000 per year for large nation-wide organizations. Examination of the questionnaires shows clearly that traffic departments produce more efficient results when permitted to function separately rather than as a part of some other major activity with an industrial organization.

CONSTRUCTION AND HOME OWNERSHIP

In each field of the department's cooperation with business, civic, and labor groups, and Government officials, important steps have been taken toward solving outstanding problems of the construction industry and home ownership. Besides the activities relating to standardization and simplification of building materials, improved wood utilization, and scientific investigations of the manufacture, uses, and properties of building materials, all of which are described elsewhere in this report, definite advances have been made in the following fields:

Uniformity of local building codes.—By completing its report on fire resistance in construction the department's building code committee has reached a new stage in its work. The seven reports which it has prepared during the past eight years involved much basic work on fundamental subjects, such as requirements for small dwellings, floor loads, allowable working stresses in design, and masonry walls. It is now vigorously engaged in consolidating, bringing up to date, and supplementing its previous reports in the form of a single volume which can be used readily as a basis for new or revised local ordinances, since a survey by the department has revealed the fact that the existing codes of several hundred cities have not undergone a major revision for at least 10 years and are thus necessarily obsolete.

At least 200 municipalities throughout the country have now made use of the committee's reports.

Stabilization of construction.—A study of the methods by which public works construction can be controlled as a practical matter in order to help stabilize employment and general business conditions, was undertaken toward the close of the fiscal year by the department in cooperation with the committee on recent economic changes of

the President's Conference on Unemployment. Data obtained thus far from the different Federal Government departments, and from State and local public works officials, planning commissions, and civic organizations throughout the country, indicate that substantial results can be attained. Application of the idea will be of far-reaching value in focusing the attention of business men, labor organizations, other groups, and public officials on the value of definite efforts to stabilize employment in other directions, and contribute materially to the general program for stabilization of employment and business, which has been one of the main concerns of the department during the past eight years. The local ups and downs of business in many cities are such as to demand the type of thought and attention that hitherto have been directed more largely to the nation-wide aspects of the matter.

City planning and zoning.—The department's service to municipalities actually concerned in problems of city planning has continued to be in demand. More than 800 cities now have officially established planning commissions, and substantially the same number have zoning ordinances in effect. More than 35 States have used the department's standard State zoning enabling act. The standard city planning enabling act, by the adoption of which States may confer adequate city planning powers upon municipalities, has already served as the basis for acts in a number of States. The rapid extension and application of city planning and zoning unquestionably results in reducing the great wastes which arise when buildings or public improvements are poorly located.

Small house construction.—Groundwork for a constructive program for improvement of small house design and construction was laid by a field survey of several hundred newly erected small houses in cities throughout the country. The information obtained, which is directly of great interest to many business and professional groups, will also be of basic value for systematic efforts to improve the quality of structures, reduce costs, and educate the public to be more discriminating in its demand for homes. It is believed that the information obtained as to common dimensional standards will open the way for further simplification of sizes and thus permit economies in their manufacture and use.

Home-owners' problems.—Following the issuance of a bulletin on Present Home Financing Methods, which aimed to aid prospective home owners in making satisfactory financial arrangements for the purchase of homes and to encourage the development of more adequate provision for their needs, the department commenced a study of the conditions under which secondary financing companies operate. The belief is widely held that existing State legislation is a deterrent to the entrance of more capital into this field, and to the efficient organization of this type of financing as part of the recognized financial organization of the community. The study revealed a lack of data regarding the reasonable needs of a community for financing above the customary first mortgage, and regarding the risks due to instability in the value of residential property. The need for a comprehensive study of the subject and for the formulation of a constructive remedial program is evident, and steps are being taken which it is hoped may lead to such a work in cooperation with private groups concerned.

HUMAN SAFETY

Reduction of waste, through preventive measures, in that greatest of all national resources—human life—has gone forward steadily, yet much remains to be done in this direction. As our population grows, as our means of locomotion increase in variety and speed, and as the number of persons engaged in hazardous occupations and pursuits increases, we are confronted in increasing magnitude with the problem of safety and protection to human life.

Through educational and legislative measures, through extension of compensation insurance into areas not now reached by it, and by quickened public interest in the wisdom and value of such effort will we accomplish the reduction of our annual fatalities. It has been well demonstrated that a large percentage of these are avoidable, and because of that fact we should assume a greater personal and national responsibility toward their prevention.

The annual economic loss to the Nation through accidents, injuries, and occupational diseases is estimated upward of \$1,500,000,000.

The Department of Commerce is cooperating to increase safety, as follows:

On the street.—Due to the increasing interest in uniform motor vehicle laws and regulations the National Conference on Street and Highway Safety has during the past year had heavy calls for the Uniform Vehicle Code, the Model Municipal Traffic Ordinance, and related materials. There was substantial progress toward uniformity through adoption of laws and ordinances in harmony with the conference models in additional States and municipalities. Toward the close of the year steps were also taken to organize new committee studies of several important subjects not covered by previous conference reports. Twenty States have enacted laws based on the Uniform Vehicle Code.

The Model Municipal Traffic Ordinance, which was completed in August, 1928, has been put into effect in two States, New Jersey and Wisconsin, by State legislation embodying substantially its provisions, and has also been adopted by numerous cities and towns in other States.

The report on street traffic signs, signals, and markings prepared for the national conference by a committee of the American Engineering Council and completed in March, 1929, has been widely distributed to cities and towns interested in standardization of these traffic facilities.

During the past summer three new committees of the National Conference on Street and Highway Safety were appointed to carry on more intensive work along certain lines within the scope and purpose of the national conference: (a) Protection of railway grade crossings and major highway intersections, (b) maintenance of motor vehicle, and (c) measures for relief of traffic congestion. A fourth committee to review the conference models for uniform State laws and ordinances has also been authorized.

In production.—Seventy-eight per cent of all the manufacturing industries in the United States are driven by electrical power, as shown by the census reports issued in 1929. The National Electrical Safety Code, published by the Bureau of Standards, is a reasonably complete standard dealing with the generation, transmission, and utilization of

electricity, and accordingly applies toward the elimination of waste in life and limb in the large majority of our manufacturing industries.

The National Electrical Safety Code has received the general support of all those affected and has exerted a powerful influence toward securing better electrical construction. It, or parts of it, are recognized officially by about half the 48 States. The casualty insurance interests have as a group adopted the code and are applying it in their inspections and rating schedules. Even in situations where legal enforcement or casualty insurance differentials do not extend there is so much interest in the subject of safety in industry and so many managers are anxious to have their employees properly protected that the rules of the code are applied voluntarily. The existence of a generally recognized standard facilitates the accomplishment of protection against electrical accidents desired by industrial managements.

In the year 1928-29 a new edition of the Discussion of the National Electrical Safety Code was issued as Handbook No. 4. The code incorporates accident-prevention precepts in the electrical industry. The discussion elaborates the reasons for these precepts and the methods for their application to good engineering practice. Many suggestions have also been included which are not found among the more formal rules of the code but which have bearing upon good practice in relation to electrical safety.

Activities allied with the development of the National Electrical Safety Code include cooperation in the preparation of the 1929 National Electrical (Fire) Code and a standard of the American Mining Congress for use of electricity in metal mines. A 1929 edition of the electrical code was also prepared which combines the accident-prevention and fire-prevention rules of the other two codes.

The lack of national uniformity in industrial safety codes and laws has resulted in retarding developments toward safety in industry.

The Bureau of Standards through its safety standards section has participated in the work of the committee preparing or revising a number of nationally recognized industrial safety codes.

In mining.—The Bureau of Mines has proceeded vigorously with its educational campaign designed to bring about safer and more healthful working conditions among the employees of the mining, quarrying, metallurgical, oil, and gas industries. More than 81,000 of these workers were trained in first-aid or mine-rescue methods during the year, bringing the total number so trained by the bureau since its establishment to approximately 365,000. The Bureau of Mines safety studies were concerned largely with the prevention of mine explosions, the reducing of heavy loss of life from falls of mine roof and coal, the elimination of hazards from use of unsafe types of explosives and mechanical equipment, and the improvement of ventilation conditions in mines. Attention was given to health and sanitation problems affecting workers in the mineral industries, with special reference to poisonous gases, unwholesome dusts, and unhealthful conditions of temperature and humidity to which the miner is frequently exposed.

At sea.—The activities of the Coast and Geodetic Survey operate to eliminate waste in many different ways. First and most important is the safeguarding of life and property at sea and in the air by the compilation and issue of nautical charts and aeronautical maps.

The degree of safety with which a mariner may navigate his ship along a coast and into the harbors of that coast depends almost entirely on the quality of the chart that is his guide. The work of providing adequate and accurate nautical charts for the coasts of the United States and its off-lying possessions has progressed steadily for many years. It is a stupendous task on account of the vast extent of our coasts, the changeable nature of large sections, and the growth of demands (due to increase in size and speed of ships and the commercial development of our country) for new charts and for additional information on existing charts.

While far from complete, this work has now reached the stage where economic waste resulting from shipwrecks on uncharted dangers or through uncertain knowledge of ocean currents, once a common occurrence, has been practically eliminated.

Next in importance to the safety with which passengers and cargo may be transported on the water is the saving in time of passage from port to port and in handling vessels in harbors and other restricted waters that is made possible by the adequate charts and accurate tide and current predictions provided by the Coast and Geodetic Survey. In the present-day era of high-speed ships, large operating costs, and keen competition, this is a matter which no steamship operator can afford to neglect. This service to the maritime public has a far-reaching effect on the economic aspects of water transportation.

The operations of the bureau on land also are of material assistance in the elimination of waste. One of the most important of these is the execution of control surveys which are the foundation of all accurate topographic maps. Accurately controlled maps have been found invaluable in many engineering and industrial operations such as hydroelectric power development, drainage and irrigation projects, flood control, and highway location. In highway construction alone immense savings may result from the availability of suitable maps. There is a record of one case where a highway was projected from an ordinary location survey and was later relocated after an accurate topographic map was completed. The new route is 7.3 miles shorter than the one first planned and the estimated saving in cost of construction is \$200,000. The topographic map cost \$2,200.

Other contributions along this line are the bureau's magnetic data, which are used to an increasing extent in the search for oils and minerals, and its cooperative seismological work, which can not fail to have a far-reaching effect with respect to public safety and the protection of property in regions subject to earthquakes.

The Steamboat Inspection Service plays an important part in the elimination of waste in lives and property in the marine field. These activities include the inspection and reinspection of vessels in American waters to determine their seaworthiness and required equipment in life-saving devices.

During the fiscal year ended June 30, 1929, 328,465,552 passengers were carried on steam vessels that are required by law to report the number of passengers carried. There were 86 passengers who lost their lives. It will, therefore, be seen that 3,819,366 passengers were carried for each passenger lost. The record for ocean and coastwise vessels alone makes an even better showing than this. On ocean and coastwise vessels 298,430,673 passengers were carried. Sixty

passengers lost their lives, making a total number of 4,973,844 passengers carried for each passenger lost.

Congress passed the load-line law March 2, 1929, applying to all merchant vessels of 250 gross tons or over, loading at or proceeding on a foreign voyage by sea from any port within the United States or its possessions. The department has organized an appropriate committee of experts actively engaged in preparing the regulations under which these load lines will be fixed. One of the outstanding purposes of this law, which has been actively advocated by the department for some years, is to conserve life and property through preventing the overloading of vessels.

During the year the United States was represented at an International Conference on Safety of Life at Sea in London, when a comprehensive convention was signed by the United States and 17 of the principal maritime nations. This convention, the preparatory work for which was under the direction and supervision of the Department of Commerce, undoubtedly is the most important step ever taken by maritime nations to promote the safety of life at sea. Its provisions covered the construction and equipment of vessels, their life-saving and fire-extinguishing appliances, their navigation, the patrol of the seas to give notice of icebergs and floating obstructions, and the equipment of practically all merchant vessels with radio apparatus.

Navigation inspectors, in preventing the overcrowding of passenger vessels, made 8,453 counts covering 5,536,831 passengers. In 177 cases it was necessary to stop passengers going on board, the limit of safety having been reached, involving 169,875 passengers.

Important progress was made by the Lighthouse Service the past year in connection with the work of the department in its efforts for increased safety of all who go to sea. The work of extending, maintaining, and improving aids to marine navigation has been pushed steadily, including construction of lighthouses and lightships, with improvements in illuminating and fog-signal apparatus. The improvement in apparatus and equipment is given constant attention and is a material factor in increasing the safety of ships at sea. Outstanding improvements include radiobeacons and automatic lighting apparatus. The extended use of automatic apparatus is not only a considerable direct economy, but it permits an extension of aids to navigation which might to some extent be difficult.

In addition to the beacons for the guidance of shipping, valuable aid is rendered by lighthouse keepers and by the vessels of the Lighthouse Service, in rescuing and giving assistance to vessels and persons in distress.

The Lighthouse Service has cooperated in the extension and improvement of facilities for air navigation during the past year, including the establishment and maintenance of civil airways and their equipment, with intermediate landing fields, beacon lights, signal and radio apparatus, and other aids to air navigation, and the maintenance of a weather service on the airways. Important improvements in lighting and other apparatus and equipment have been made.

In the air.—The Aeronautics Branch of the Department of Commerce has always made the assuring of safety of pilots, passengers,

and public one of the primary objectives in its work of promoting aeronautics as an aid to commerce.

By establishing airways, licensing and inspecting aircraft, examining and licensing pilots, inspecting and rating flying schools, and by a score or more of kindred activities, the Government is rapidly developing that sense of security and safety which is so essential to the full utilization of air transport.

The use of radio devices has played an important part in the development of modern business through the utilization of this means of economical, rapid, and accurate system of communication. Furthermore, reduction of waste must be considered to their credit, not only from the direct savings made available but also for the conservation of life and property. To-day, radio is acting as a safeguard and protection for an ever increasing number of lives and amount of property. Those who use ship or aircraft transportation benefit through its world-wide protection.

Through the means of ship-to-shore radio communication the courses of vessels carrying valuable cargoes or vessels in search of a cargo may be guided in such a manner to obtain a maximum of service and much waste avoided thereby.

Radiobeacons have been established at strategic points along our coasts for the purpose of transmitting radio waves in a somewhat similar way to a beacon of light. Vessels equipped with a radio-compass receiver can intercept these transmissions and determine their exact position. Vessels can now be safely guided to port through the densest fog with very little or no delay. In former days vessels approaching the coast would necessarily be required to await clear weather before entering the harbor, often resulting in a loss of time amounting to several days. When a disaster occurs at sea the rescuing vessel or vessels can more readily locate the disabled vessel by means of the radio compass. It is indispensable for such purposes when the visibility is low.

The transmission of time signals, weather and iceberg reports, and other meteorological information is an important adjunct of efficient and safe maritime navigation. Even very small vessels equipped with an inexpensive receiving set find these services of much value.

Radio-compass stations now located at entrances to all of our important harbors can accurately ascertain the position of any vessel within range if the vessel is equipped with radio transmitting and receiving apparatus. This service is rendered without cost to the individual vessel.

The use of facsimile transmitters now permits of the direct transmission and reception of weather maps, documents, etc., heretofore impossible, resulting in a wider service to the public and consequent greater economy of natural resources through the use of radio stations.

PROGRESS IN DEVELOPMENT OF CIVIL AERONAUTICS

[By WM. P. MACCRACKEN, Jr., Assistant Secretary of Commerce for Aeronautics]

During the fiscal year 1928-29 civil aeronautical developments taken as a whole in this country not only more than doubled their own records of the preceding 12-month period but also far exceeded the optimistic forecast of a year ago.

It is indeed gratifying to be able to report that the aeronautical services of the department were able to meet these added responsibilities, which were unexpectedly placed upon them, in a manner generally satisfactory to the industry and the public. While there is still urgent need for additional personnel and funds, the work of the aeronautics branch is more nearly current than it was a year ago.

At that time routes over which scheduled service was maintained totaled 11,196 miles. To-day regular operations are conducted over routes 29,227 miles in length; the daily scheduled trips require 69,029 miles of flying. Much of this flying is done at night, making use of the lighting facilities which this department maintains along 10,183 miles of airways. Of these, 4,266 miles were established during the past year. But of more importance than the extensions of the lighted airways have been the improvements and expansion of radio and weather service as aids to air navigation. Experiments are being conducted looking to a still greater degree of perfection in these facilities. But the progress already made demonstrates conclusively that greater safety and reliability in air operations will result as more radio aids and weather information are made available.

Three-fourths of our entire population live near enough to our existing air routes to be able to gain some advantage from the services offered. That they are availing themselves of this opportunity is partially evidenced by the fact that air-mail poundage increased from 1,861,800 pounds for the preceding fiscal year to 5,635,680 pounds for the year just closed. Increases in air express and passenger traffic were as great in proportion. While it is still true that a comparatively small percentage of the entire volume of traffic in this country is being moved through the air, it is obvious that air operations will each year constitute a more important factor in our transportation service. Rates, except for domestic air mail, are relatively high, but apparently there is a substantial volume of traffic which can afford to pay the present premium charge for speed and service. Perhaps even more important is the fact that as aviation develops costs should and will be reduced, thereby increasing the field from which air traffic will come.

There has been some suggestion that discrepancies in passenger fares and express rates charged by the various air-transport operators would justify Federal regulation of this phase of interstate air commerce in order to protect the public from discrimination.

When one considers that commercial air transportation is only three years old in this country, it is obvious that it could not possibly be standardized sufficiently to permit of such regulation without irreparably stunting its growth. Furthermore, there is no such thing as monopoly in this new field and it does not lend itself to becoming a monopoly unless made such by Government subsidy or franchise.

Some who favor such regulatory measures assert that they are necessary to attract capital into air transportation or to protect that already invested. This first assertion is contrary to the facts and, as regards the second, no amount of Government regulation can eliminate the financial hazards of pioneering or the natural consequence of incompetent management which is always to be found in some degree in a new industry.

The phenomenal progress that has been made in civil aeronautics in the United States in a remarkably short space of time should be accepted as conclusive proof that our national policies in this new field are sound and in general should be continued.

Aerial service continues to require a substantial majority of the civilian aircraft and to account for the major portion of hours in the air. Much of this flying is done in giving students instruction.

This June 1,211 student-pilot permits were issued as compared with 730 in June, 1928. Heretofore there has been little or no regulation governing this phase of the industry. The last Congress, however, passed an amendment to the air commerce act, introduced by Senator Bingham, directing the Secretary of Commerce by regulation to rate flying schools. While it is not compulsory that any school obtain such a rating, it is certain that competition and the cooperation of the better schools will make this a very potent factor in improving the standards of civilian flying training. This will not only afford the student protection from unscrupulous and incompetent schools, but will decrease the accident rate due to errors in piloting resulting from inferior training. Plans carrying out this latest activity have only recently been completed. Real benefits to be derived from it will appear in the future.

It is also interesting to note that interest in civilian lighter-than-air development is becoming quite apparent. Thus far airships have not been used in commercial operations but several such ships have been built and placed in operation for the purpose of training personnel and demonstrating the possibilities of this type of service. No doubt during the next year the department will be called upon to render service in connection with this type of aerial operation. While much remains to be undertaken, both by the department and the industry, the accomplishments to date have been such as to greatly increase public confidence, which, after all, is the foundation upon which the success of our air commerce must be built.

CONDENSED REPORTS OF BUREAUS

CHIEF CLERK AND SUPERINTENDENT

DEPARTMENT OF COMMERCE,
OFFICE OF THE CHIEF CLERK,
Washington, July 1, 1929.

The honorable the SECRETARY OF COMMERCE.

DEAR MR. SECRETARY: There was no abatement during the year of our ever-continuing problem of space requirements. The situation was partially relieved by moving the division of simplified practice and the division of building and housing to the Bureau of Standards, thus providing additional space in the Commerce Building for the Aeronautics Branch and the Bureau of Foreign and Domestic Commerce. The Commerce Building is still badly crowded and more space is needed, but until the department's new building is completed a continuation of makeshift arrangements will be necessary.

On June 10, 1929, the corner stone of the new Department of Commerce Building was laid with appropriate ceremony by the President of the United States. It contained the Bible, the Constitution of the United States, a United States flag, a medallion of President Hoover, an impression of the Department of Commerce seal, a flag of the Secretary of Commerce, publications of the department, current newspapers, a one-dollar silver certificate of the series of July 10, 1929, ten 2-cent postage stamps of the series to commemorate the fiftieth anniversary of the production of the first incandescent electric lamp invented by Thomas A. Edison, and a number of other articles and publications typifying the work of the department, matters of current interest, and the march of progress of the country from its early days to the present.

Inscribed on the stone are the names of Herbert Hoover, President of the United States; A. W. Mellon, Secretary of the Treasury; R. P. Lamont, Secretary of Commerce; James A. Wetmore, Acting Supervising Architect of the Treasury; and York & Sawyer, architects. The date on the stone is 1929.

The table following shows the total amount of all appropriations for the various bureaus and services of the Department of Commerce for the fiscal year ended June 30, 1929:

Bureau	Annual appropriation act	Deficiency acts	Special act	Total	Allotments by other departments
Office of the Secretary	\$645,100.00	\$22,600.00		\$667,700.00	
Aeronautics Branch	4,361,850.00	141,050.00		4,502,900.00	
Radio Division	320,000.00	66,160.00		386,160.00	
Bureau of Foreign and Domestic Commerce	4,257,357.00	174,366.00		4,431,723.00	
Bureau of the Census	2,148,200.00	97,250.00		2,245,450.00	
Steamboat Inspection Service	1,114,060.00	55,740.00		1,169,800.00	
Bureau of Navigation	330,880.00	9,670.00	\$6,191.45	346,741.45	
Bureau of Standards	2,246,055.00	165,820.00		2,411,875.00	\$168,117.15
Coast and Geodetic Survey	2,356,580.00	98,721.32		2,455,301.32	52,000.00
Bureau of Lighthouses	11,145,250.00	391,704.09		11,536,954.09	
Bureau of Fisheries	2,123,748.00	56,360.00		2,180,108.00	
Patent Office	2,903,800.00	472,500.00		3,376,300.00	
Bureau of Mines	2,542,080.00	139,538.00		2,681,618.00	205,500.00
Printing and binding:					
All bureaus except Patent Office	715,000.00			1,855,000.00	
Patent Office	1,140,000.00				
Total	38,349,960.00	1,891,479.32	6,191.45	40,247,630.77	425,617.15

¹ Not included in appropriations

Disbursements during the year ended June 30, 1929, from appropriations and from funds transferred from other departments were as follows:

Bureau	Appropriation for—			Total
	1927 and prior years	1923	1929	
Office of the Secretary	\$526.31	\$584,354.34	\$1,853,532.96	\$2,438,413.61
Aeronautics Branch	25,967.14	1,696,972.25	3,172,049.75	4,894,989.14
Radio Division	11,263.00	50,203.69	289,384.25	350,850.94
Bureau of Foreign and Domestic Commerce	4,796.63	253,568.81	4,008,318.74	4,266,684.18
Bureau of the Census	221.46	237,901.63	1,938,768.28	2,176,891.37
Steamboat Inspection Service	38.05	103,465.66	1,046,283.87	1,149,787.58
Bureau of Navigation	2.75	28,415.72	311,267.51	339,785.98
Bureau of Standards	3,312.17	423,273.39	2,207,053.97	2,633,639.53
Coast and Geodetic Survey	6,864.03	539,690.97	2,030,420.73	2,576,975.73
Bureau of Lighthouses	803.69	691,646.55	10,377,214.35	11,069,664.69
Bureau of Fisheries	25,652.98	334,255.64	1,682,023.18	2,041,931.80
Patent Office	83.89	274,172.13	3,006,854.72	3,281,110.74
Bureau of Mines	79,058.77	221,247.34	4,371,842.46	4,672,148.57
Total	158,595.87	5,439,168.22	36,295,114.77	41,892,878.86

The miscellaneous receipts for the fiscal year are shown below, by bureaus.

Coast and Geodetic Survey: Sale of charts, publications, old property, etc	\$67,907.43
Bureau of Fisheries:	
Sale of fur seal skins	287,833.01
Sale of fox skins	62,697.41
Meals furnished employees at isolated stations	1,552.50
Sale of old property, etc	827.25
Bureau of Standards:	
Test fees	67,473.82
Miscellaneous refunds	986.17
Steamboat Inspection Service: Sale of old property	7.57
Bureau of Lighthouses:	
Sale of old property	65,317.78
Rent	4,028.00
Government property lost, destroyed, or damaged	7,638.32
Work done	3,470.19
Miscellaneous	426.65

Bureau of Foreign and Domestic Commerce:	
Registration fees, etc., China trade act.....	\$2, 125. 00
Sale of publications.....	4, 525. 57
Miscellaneous refunds.....	142. 44
Office of the Secretary:	
Certification fees (37 Stats. 497).....	609. 00
Sale of strip maps (Aeronautics Branch).....	3, 492. 28
Penalties for violation of air-traffic rules.....	4, 210. 00
Miscellaneous.....	600. 75
Patent Office: Patent fees.....	3, 693, 459. 84
Bureau of Mines:	
Analyzing samples.....	9, 349. 44
Miscellaneous.....	4, 394. 49
Bureau of Navigation:	
Tonnage tax.....	2, 014, 438. 06
Navigation fees.....	249, 483. 21
Navigation fines.....	54, 729. 90
Miscellaneous.....	100. 00
Total.....	6, 611, 826. 08

At the close of the year the personnel of the department numbered 16,744 (15,159 permanent and 1,585 temporary). Of the total number, 5,064 are employed in the District of Columbia and 11,680 constitute the field force.

The number of employees retired on annuity during the year under the civil service retirement act was 28—21 by reason of age and 7 on account of disability. The average annuity of those retired under the act is \$832.88. Under the Lighthouse Service retirement system, 31 were retired for age with an average annuity of \$1,210.17, and 19 on account of disability with an average annuity of \$923.04. A total of 754 employees have been retired under the two systems to the close of June 30, 1929.

The following statement shows for the fiscal years 1928 to 1930, inclusive, the amounts available for printing and binding and the unexpended balances of the appropriations for 1928 and 1929:

	Fiscal year		
	1928	1929	1930
Services other than the Patent Office:			
Amount available.....	¹ \$719, 000. 00	\$715, 000. 00	² \$615, 000. 00
Expenditures.....	³ 717, 362. 31	³ 704, 395. 24	
Balance.....	1, 637. 69	10, 604. 76	
Patent Office:			
Amount available.....	1, 135, 000. 00	1, 140, 000. 00	1, 100, 000. 00
Expenditures.....	999, 128. 87	³ 1, 027, 256. 31	
Balance.....	135, 871. 13	112, 743. 69	

¹ Includes \$25,000, available for printing and binding for the Aeronautics Branch, contained in Public Act 638, 69th Congress, and \$19,000 made available by the second deficiency act, 1928 (Public Act 563, 70th Cong.).

² Does not include printing and binding for the bureau of the Census. During 1930, 1931, and 1932 printing and binding for that bureau will be paid for from appropriations for the fifteenth decennial census.

³ Estimates. Exact figures can not be given until all work ordered is completed and billed.

Total receipts from sales of the department's publications for the fiscal year 1928 (the latest period for which complete data are available) were \$651,926.48, compared with \$531,882.53 for 1927. The following table presents the details in comparison for the two years by selling agencies and issuing offices:

Sales	Receipts	
	1927	1928
By the Superintendent of Documents:		
Miscellaneous sales.....	\$97, 172. 77	\$118, 214. 89
Subscriptions.....	48, 723. 98	119, 888. 26
Total.....	145, 896. 75	238, 103. 15
By Coast and Geodetic Survey: Coast pilots, inside route pilots, tide tables, current tables, and charts.....	58, 978. 63	62, 057. 83
By Patent Office: Specifications of patents, reissues, etc., trade-mark section and decision leaflet of Official Gazette, and classification bulletins and definitions.....	327, 012. 15	351, 766. 00
Grand total.....	531, 882. 53	651, 926. 48

¹ This increase is due in large measure to the increase in the subscription price of the Patent Office Official Gazette.

As in prior years, wherever possible surplus equipment was obtained to meet the needs of the branches of the department. Through the cooperation of the Chief Coordinator's Office, Bureau of the Budget, material comprising clothing, office equipment, etc., to the value of approximately \$20,000 was obtained from surplus stocks of other Government departments without transfer of funds.

Very truly yours,

E. W. LIBBEY,
Chief Clerk and Superintendent.

AERONAUTICS BRANCH

DEPARTMENT OF COMMERCE,
OFFICE OF THE DIRECTOR OF AERONAUTICS,
Washington, July 1, 1929.

The honorable the SECRETARY OF COMMERCE.

DEAR MR. SECRETARY: In compliance with your request the following report is submitted, describing the state of air commerce and briefly summarizing the activities of the Aeronautics Branch of the department during the fiscal year ended June 30, 1929.

I. ORGANIZATION AND FUNCTIONS

In three short years, the Federal Government has assisted materially in reducing the problems of air transportation to terms of business, industry, and commerce. The Aeronautics Branch of the Department of Commerce completed on June 30, 1929, its third year of activities authorized by the air commerce act of 1926, which charged the Secretary of Commerce with the promotion and regulation of civil aeronautics. The fundamental principle of this act, which was passed with the approval of the aeronautical industry, is to afford aviation every possible opportunity to regulate itself. The industry has always cooperated most heartily with the Federal Government, for it recognized the imperative need of national guidance and control.

The air commerce act was passed to provide this necessary guidance and control, the direct result of which was the organization of the Aeronautics Branch of the Department of Commerce. The branch has utilized existing Government agencies wherever possible; and in addition it has created new divisions and sections when necessary, in order to execute the various provisions of the air commerce act. These provisions include:

1. The inspection and licensing of aircraft.
2. The examination and licensing of airmen.
3. The identification of aircraft.
4. The establishment and enforcement of air traffic rules and regulations.
5. The investigation of aircraft accidents.
6. The assembly of all data pertaining to these subjects.
7. The establishment and maintenance of civil airways.
8. The equipping of airways with suitable intermediate landing fields, beacon lights, radio apparatus, and other aids to aerial navigation.
9. The maintenance of comprehensive airway weather service.
10. The charting of airways.
11. The publication of air maps.
12. The conduct of scientific research and development work to create and improve air-commerce facilities.
13. The rating of flying schools.
14. The publication of air-commerce bulletins.
15. The encouragement of municipal airport construction.
16. The rating of airports.

17. The issuance of detailed data on individual airports.
18. The collection and dissemination of air-commerce information; and
19. The general promotion of air commerce, industry, and trade.

The duties imposed by this act have been distributed as far as practicable among existing Government agencies. The task of surveying, establishing, operating, and maintaining aids to navigation along air routes was assigned to the Bureau of Lighthouses; the charting and mapping of air routes, to the Coast and Geodetic Survey; and the scientific research for improvement of air navigation facilities to the Bureau of Standards.

Since the department had no facilities for examining and licensing aircraft and airmen, for promulgating and enforcing air traffic rules and regulations, for encouraging airport construction by municipal and private interests, or for collecting and disseminating aeronautical information, it was necessary to set up a number of new instrumentalities. The aeronautic activities of these new instrumentalities as well as of the existing agencies, however, are all coordinated under the direct supervision of the Assistant Secretary of Commerce for Aeronautics, the Director of Aeronautics being in immediate charge. The functions of these agencies and instrumentalities follow.

AIR REGULATIONS DIVISION

The air regulations division is directly concerned with the construction and operation of civil aircraft in all its phases. By determining and enforcing definite standards of safety, it has established and maintained public confidence and thereby played a large part in the phenomenal growth of air commerce and the aircraft industry.

The division is composed of five principal sections: (1) Inspection, which is divided into field, factory, engineering, and school rating groups; (2) engineering; (3) medical; (4) licensing; and (5) enforcement. During the past year, a sixth section (statistical) was organized for the purpose of handling the work incident to aircraft-accident analysis and developing therefrom vital statistics. The statistical function of this section was transferred to the division of airports and aeronautic information when the latter was created. The function of collecting accident reports and analyses up to the point of developing statistical data, however, remains a function of the air regulations division under the direct supervision of the division chief.

The chief of the division is responsible to the director of aeronautics for the general administration of the division and for organizing, supervising, and coordinating the work of the sections as hereafter outlined.

TABLE A.—Status of aircraft, pilots, and mechanics, by States, June 30, 1929

	Aircraft		Pilots	Mechanics		Aircraft		Pilots	Mechanics
	Licensed	Identified				Licensed	Identified		
Alabama.....	15	5	39	30	Nevada.....	2	8	11	17
Arizona.....	15	18	20	16	New Hampshire.....	9	7	7	7
Arkansas.....	24	32	51	39	New Jersey.....	97	74	115	178
California.....	518	378	1,167	877	New Mexico.....	3	8	6	1
Colorado.....	37	23	82	52	New York.....	752	248	551	459
Connecticut.....	43	21	52	43	North Carolina.....	29	59	34	23
Delaware.....	16	4	9	8	North Dakota.....	14	25	8	14
District of Columbia.....	60	6	183	106	Ohio.....	230	98	267	308
Florida.....	36	53	117	130	Oklahoma.....	134	97	111	79
Georgia.....	20	42	44	26	Oregon.....	36	29	61	64
Idaho.....	14	14	16	11	Pennsylvania.....	244	117	265	280
Illinois.....	299	247	312	375	Rhode Island.....	9	18	10	10
Indiana.....	84	96	117	82	South Carolina.....	13	20	14	14
Iowa.....	51	63	56	86	South Dakota.....	28	29	23	20
Kansas.....	81	122	116	93	Tennessee.....	33	34	67	43
Kentucky.....	18	26	39	24	Texas.....	173	143	244	235
Louisiana.....	44	37	40	45	Utah.....	21	11	36	39
Maine.....	4	12	12	9	Vermont.....	6	4	9	3
Maryland.....	32	39	53	56	Virginia.....	26	42	111	198
Massachusetts.....	109	64	141	113	Washington.....	108	79	127	114
Michigan.....	235	140	297	307	West Virginia.....	7	21	16	13
Minnesota.....	92	72	108	82	Wisconsin.....	121	82	112	52
Mississippi.....	18	12	27	10	Wyoming.....	10	10	29	28
Missouri.....	193	131	191	139	Alaska.....	7	7	9	13
Montana.....	19	48	31	22	Hawaiian Islands.....	3	2	29	47
Nebraska.....	40	73	49	71	Total.....	4,232	3,055	5,641	5,111

INSPECTION SECTION

The inspection section is charged with the examination and licensing of pilots, mechanics, and flying-school instructors, and with the inspection and approval of airplanes and flying schools. In addition, it is charged with all field work in connection with enforcement of the Air Commerce Regulations, including the air traffic rules and the investigation of aircraft accidents.

The inspectors employed in this work are of two general classes: (1) Pilots of unusual qualifications who, on account of the nature of their work, must have not only a thorough knowledge of airplanes and airplane construction but also sufficient tact and diplomacy properly to meet the public and carry out the work of examining pilots and mechanics and of inspecting aircraft in the field; (2) airplane inspectors stationed in the various aircraft factories, who are selected for their intimate knowledge of structural details in the manufacture of aircraft and are not necessarily pilots. Approximately three-fourths of the total inspection personnel are men of the former type, while the balance are nonflying (factory) airplane inspectors.

At the close of this fiscal year, the inspection section is in the unique position of being current with its work regarding the handling of new applications for license. This condition, which has long been sought, has been accomplished only through the employment of a high type of personnel whose willingness to work overtime has operated constantly for the benefit of the organization and the industry.

The pilot inspectors are subdivided into three general classes: (1) Aeronautical inspectors, (2) aeronautical engineering inspectors,

and (3) aeronautical school inspectors. The first class examines pilots and mechanics, and inspects airplanes for original as well as for renewal licenses. They operate under the jurisdiction of supervising aeronautical inspectors, who are in charge of the nine principal districts into which the country is subdivided.

Aeronautical engineering inspectors inspect and test, in actual flight, all new types of aircraft to determine their eligibility for an approved-type certificate, or for license. They also conduct factory inspections of the various factories involved, and carry out such field tests as may be deemed necessary by either the inspection or engineering sections.

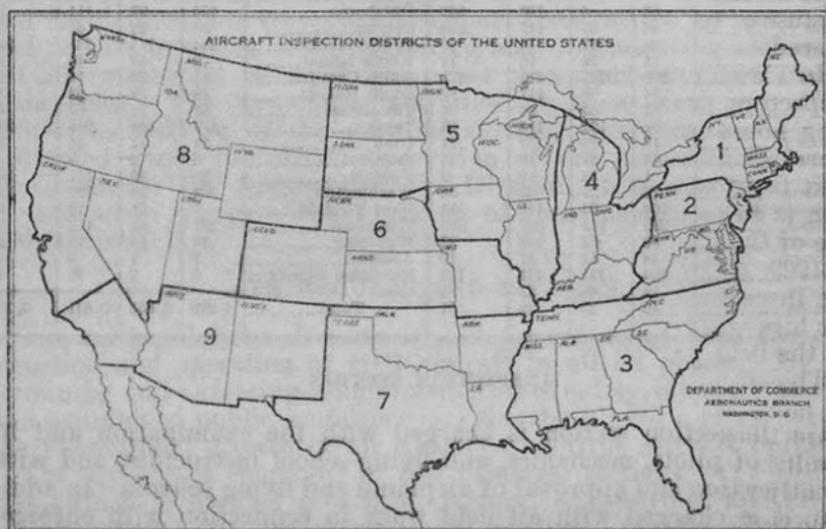


FIGURE 2

The third class examines and flight tests flying-school instructors, and inspects flying schools to determine their eligibility for an approved school certificate. The above personnel is all itinerant and operates directly or indirectly under the jurisdiction of the various supervising aeronautical inspectors.

Airplane inspectors who are not pilots operate under the jurisdiction of a supervising airplane inspector. These men are permanently stationed at the various airplane factories and devote their entire time to the minute inspection of airplanes during construction and to the licensing of them upon their satisfactory completion.

There are approximately 45 of the flying type of inspectors and 15 of the factory type in the section at this time, a total of 60. On account of the scarcity of men who have qualifications necessary to hold successfully either type of inspection position and because of the training they receive from the department, they are in great demand by manufacturers and operators; they are, therefore, employed by these outside agencies at greatly increased salaries whenever they can be induced to leave the department. In order to prevent a high rate of personnel turnover, all inspectors are employed with a distinct understanding that unless discharged for cause they

will remain in the service at least one year. They then pass through a probationary period in order that those found to be undesirable or unqualified may be removed from the service without undue delay.

It is believed only just and equitable that these members of the field service who are engaged regularly in extra hazardous flying, involving the testing of new types of aircraft and of new pilots for license, be afforded additional compensation to cover the unusual hazards involved. Although the past record is considered good, two inspectors have lost their lives during the year in this work. Such compensation, which is accorded other flying branches of the Government, would have the effect of retaining in the service a responsible type of man who may otherwise yield to the pressure of the industry because of the greater financial advantages which are being constantly offered.

In view of the fact that all inspectors, especially the aeronautical inspectors, are operating under a high nervous tension and work for long hours in order to handle the tremendous volume of work, an increase in the personnel will undoubtedly be necessary before the next fiscal year terminates. This is especially true if proper attention is to be given to aircraft-accident investigation, which is only one of the many duties of the inspectors. In addition, after October 1, 1929, all grades of pilots' licenses will be renewed in the field by the inspectors, and the licenses granted to pilots who carry persons for hire will be subdivided; all of which will throw an added burden on the field personnel.

The efficiency of the section could be further increased by the use of more airplanes, were they available. Unfortunately, there are more than four inspectors to each airplane at their disposal; the result is that the majority of travel must necessarily be by rail, thus greatly retarding the work of inspection. Obviously, the bulk of the inspectors' work is located at the various airports, which necessitates not only rail transportation but other means of travel from the rail terminals to the airports. Consequently, much time is saved, more work accomplished, and better service rendered when an airplane is used.

LICENSING SECTION

The licensing section is responsible for the preparation and issuance of all aircraft, pilot's, and mechanic's licenses and their renewals; the transfer of titles to aircraft assigned Department of Commerce numbers; the issuance of certificates of airworthiness for export, for aircraft to be exported to foreign countries having reciprocal agreements with the United States; and for the validation of such certificates and the maintenance of all files and records pertaining to the above.

For the fiscal year 1929, the output in volume of work for the licensing section has more than doubled. This increase, although primarily due to a natural increase in incoming applications for the various classes and types of licenses, has been appreciably augmented by additional work, such as additional examinations to be checked and much more rigid eligibility requirements for pilots, mechanics, and all types of aircraft, made necessary by the depart-

ment's own rapid development toward more competent pilots and safer planes. Applications continued to be received throughout the fiscal year in a smooth and steadily increasing volume, indicating a much more stable condition than has heretofore existed.

Student applications continued to be received at a rate beyond all reasonable expectation and showed an actual increase of 477 per cent over the previous year. This increase, however, has no real bearing on the number of future pilots. Figures indicate that for every 100 students, only about 15 per cent ever get beyond the student stage. This latter figure is also somewhat misleading in that it can not be considered indicative of the percentage of students who are unable to learn to fly. It more nearly indicates a large group of people who, for technical or personal reasons, are interested in first-hand information on the principles of flying, but who have no intention of becoming pilots or accomplishing more than possibly a single solo flight.

At the present time Canada and Colombia are the only foreign countries with which the United States has a reciprocal agreement for the mutual validation of airworthiness certificates for export. In spite of this limited field, certificates of airworthiness for export were issued for 114 airplanes during the fiscal year to Canada alone, as against a total of 60 for all previous years. Although many airplanes were exported to other foreign countries, no export certificates could be issued because of the absence of reciprocal agreements with these countries.

To date, aircraft of the lighter-than-air class have not constituted a licensing problem. Eight or ten free balloons have been issued identification numbers and four dirigible airships have been issued licenses. No provision has yet been made for examining and licensing dirigible pilots, but letters of authority to operate as such have been issued to the few who have so far applied.

During the fiscal year a total of 42,338 licenses, license renewals, title transfers, and export certificates were issued as against 14,083 for the previous year. Figure 3 (p. 13) is arranged to show this growth relative to the various types of licenses issued. At the beginning of the fiscal year the renewing of licenses and the transferring of titles were just beginning to be really felt. This work, entirely additional to the issuance of original licenses, has now grown to where it constitutes 29 per cent of the total volume of work; and as airplane licenses must be renewed annually and a majority of the pilots' licenses semiannually, this phase of the work will continue to grow until it constitutes the major portion of the total volume. The lower curve on Figure 3 shows the steadily increasing rate at which new applications have been received. The upper curve indicates the constantly increasing volume of work necessitated by license renewals and the transferring of title to aircraft formally assigned Department of Commerce numbers.

To keep the issuance of licenses current with such an increase in the volume of work has necessitated many radical changes. The office routine has been reduced to an absolute minimum and form letters are now being used wherever possible. An effort has been made to make all licenses and license applications as self-explanatory as possible in an effort to reduce correspondence. Many office records

formerly deemed essential were discontinued through necessity, and many valuable statistics have had to remain buried in the files, due to lack of personnel to compile them.

The absorption of some of this work increase has been made possible through changes resulting from experience gained during the previous year of operation. A new files group has been created which handles all of the files of the licensing section as a unit, thus avoiding much duplication. Modern machines are now in operation for the typing of identification-mark assignments and all of the various classes of aircraft licenses. These machines automatically type all office and statistical file copies, eliminating costly duplication of effort. This same system is now being developed for the typing of all pilot's and mechanic's licenses. When all classes of licenses can be typed on these machines the office routine will not only be materially reduced but statistics now unavailable because of lack of time for assembling will begin to become accessible.

These savings, although material, do not compensate for the radical increase in the actual volume of work. Moreover, there are several difficulties yet to be corrected, especially along the lines of educating the public as to the details of the department's requirements.

In spite of past efforts, much confusion still exists relative to the requisites for transferring title to aircraft bearing Department of Commerce numbers. This necessitates a tremendous volume of correspondence which seriously handicaps the performance of the work. In an effort to remedy the situation, an entirely new system for handling transfers of title has been devised. A "record, transfer, and reassignment" form is being mailed to the owners of aircraft, along with the license or identification mark. This form is self-explanatory and, when properly completed and returned to the Department of Commerce, constitutes sufficient evidence of sale to support transfer of title to a new owner.

Confusion has also persisted relative to the renewal of each class of license. Although all licenses plainly display their expiration dates, and notices are sent out by the department calling attention to the expiration date and explaining the requisites for renewal, a great many airplane owners and pilots fail to renew their licenses at the proper time and a vast amount of correspondence ensues. This situation has been carefully studied and very shortly a new system of renewing licenses will be put in effect which will relieve the licensing section of much of this burden.

Another difficulty encountered throughout the fiscal year was due to the absence of provision in the air commerce regulations for registering aircraft in the names of purchasers in cases where title was reserved by the seller until the full purchase price had been paid. This necessitated much correspondence and many delays, and constituted a decided detriment to the marketing of aircraft. The air commerce regulations have since been revised and a system is being developed whereby licenses can be issued to owners and operators who are purchasing their airplanes on partial-payment plans.

The demand for rush information on ownership or status of aircraft, status of license applications, etc., necessitates telegraphic replies to from 20 to 50 incoming wires per day. This represents a

large amount of work in that practically all telegraphic requests refer to new applications not yet classified or filed. In a large number of cases, other sections of the Aeronautics Branch must be contacted in order to coordinate the replies.

Although a radical saving has been effected through a reduction of office routine and the utilization of modern equipment, the volume of work has continued to increase at a decidedly faster rate than personnel could be increased to handle it. A résumé of the work shows that 50,000 original and renewal applications were received and acted upon and that out of this number 42,338 original or renewal certificates were issued authorizing operation in connection with aircraft. This represents an increase in volume of work of 204 per cent whereas it has only been possible to increase the personnel 43 per cent, with the result that keeping the issuance of licenses current has been and still is extremely difficult.

	Fiscal year		Increase	Percentage of increase
	1927-28	1928-29		
Pilots' licenses issued.....	2,632	5,137	2,505	95
Pilots' licenses renewed.....	808	4,687	3,879	480
Student permits issued.....	2,682	15,868	13,186	491
Aircraft licenses issued.....	1,728	4,379	2,651	153
Aircraft licenses renewed.....		727		
Identification marks assigned.....	1,328	3,256	1,928	145
Mechanics' licenses issued.....	2,806	3,264	458	16
Mechanics' licenses renewed.....		75		
Export certificates issued.....	60	114	54	90
Transfers of title completed.....	2,089	4,906	2,817	141
Total.....	14,083	42,418	28,330	200

ENGINEERING SECTION

The primary function of the engineering section is to determine whether or not aircraft which are to be made eligible for license are of proper structural design.

What is known as an approved-type certificate is issued to aircraft manufacturers meeting certain stipulated requirements. This entitles the manufacturer to build aircraft of exact similarity to an approved model, which are then eligible for commercial license. In order to obtain such a certificate, the manufacturer must first submit complete technical data, together with stress analyses and blue prints of his aircraft, all of which are forwarded to the engineering section of the air regulations division in Washington. Here the plans are carefully checked to make sure that the design of the structure possesses the required margin of safety and adheres to accepted engineering practice.

This requires the attention of aeronautical engineers who are familiar with all the mathematical processes of aircraft analysis and design, technicians who are authorities on all the structural details and types of construction that can be applied to aircraft.

This does not prohibit the department's approval of a radical or new type of design, for approval may be obtained if the structure is justified either by mathematical computation or by actual physical

tests. When the engineering section has approved the design, the manufacturer is required to present a standard machine for inspection.

Here the inspection section takes up the work. The airplane is examined to determine if it is built according to the design submitted; it is checked for detail design, workmanship, and materials; it is weighed and thoroughly flight tested to make sure that it satisfies the stability requirements of the department and has no undesirable flying characteristics. The factory is also inspected to determine whether or not it is suitably equipped and manned to produce aircraft exactly similar to the design submitted. When this structural check, practical flight test, and factory inspection are satisfactorily completed, the manufacturer is issued an approved-type certificate for this particular model; and henceforth this plane

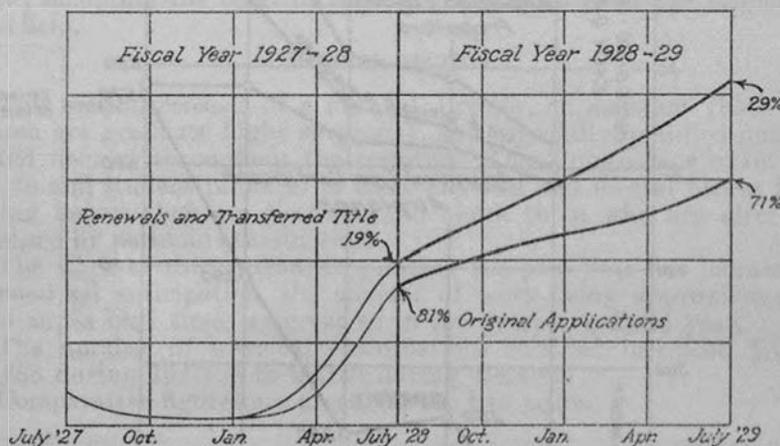


FIGURE 3.—Original applications and renewals

is approved for license so long as the workmanship, materials, and design are adhered to according to required standards and are found by periodic inspection to be in airworthy condition.

Engines, too, which are to be used in licensed aircraft must be of a type approved by the engineering section. All engines which have not been subjected to an acceptance test by the Army or Navy air services must pass a Department of Commerce test. These tests are being performed by the Bureau of Standards. Propellers are in the same category and must be approved before being used in licensed aircraft.

During the past fiscal year 121 approved-type certificates were granted for airplanes, 21 approved-type certificates were granted for engines, and 28 approved-type certificates were granted for propellers. In addition, 65 different types of airplanes were examined and approved without being granted approved-type certificates, and 13 types of engines were approved on the same independent basis. The total number of approvals granted to airplanes, engines, and propellers during the fiscal year, therefore, amounts to 248. This is three and a half times the amount of work handled during the previous year which amounted to only 72 approvals.

The volume of incoming work is increasing steadily and shows no signs of diminishing.

Seventeen per cent of the year's work was received during the first quarter, 16 per cent during the second, 27 per cent during the third, and 40 per cent during the last quarter. Approvals were granted

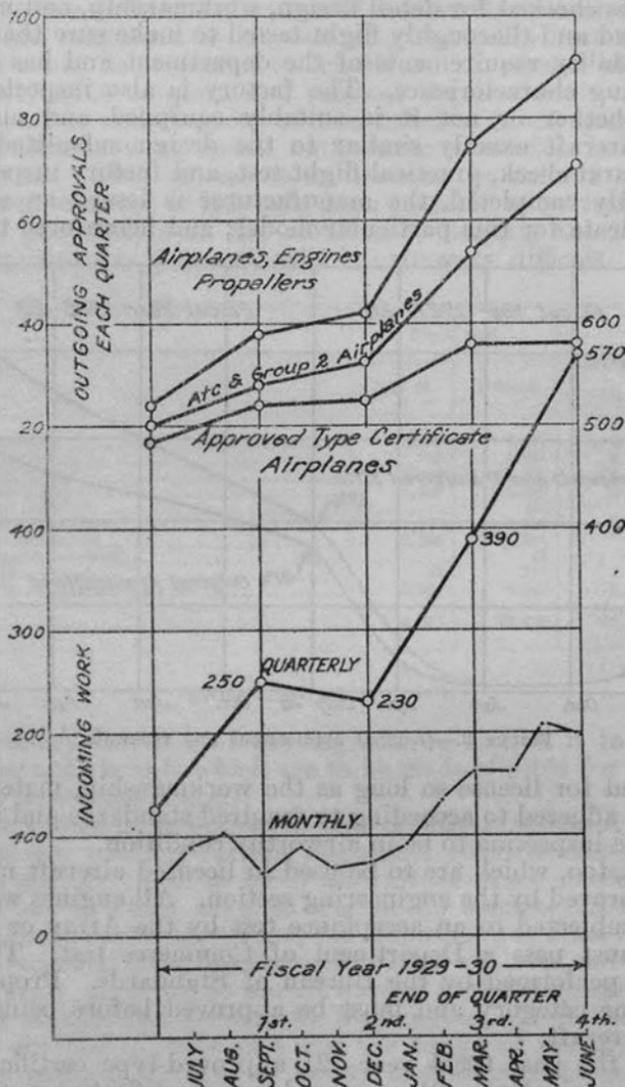


FIGURE 4.—Incoming work and outgoing approvals

NOTE.—By Group 2 is meant airplanes approved for license but issued approved type certificates because of the extremely limited quantity to be produced.

in accordance with the same mounting scale; that is, 15 per cent in the first quarter, 17 per cent in the second, 31 per cent in the third, and 37 per cent in the fourth quarter.

It was found necessary to revise and rewrite the Airworthiness Requirements (Aeronautics Bulletin 7-A), in order to keep pace with the rapid development in the design and construction of air-

craft, engines, and propellers. This was accomplished during the year and the revised requirements became effective on July 1, 1929.

In addition to this work, a large volume of miscellaneous technical correspondence of a general informative nature flows continuously through this office.

The section at present is about three weeks behind in checking stress analysis. Last year additional engineers were employed during the summer months to dispose of an accumulation of work and reduce it to a current status. These engineers were available because of being university faculty members and therefore in a position to accept other employment during the summer vacation period. This year these men were not available to the Government owing to the greatly increased demand for aeronautical engineers in the industry. For the same reason, nine engineers of the regular staff, including the chief of section, resigned to enter the commercial field.

MEDICAL SECTION

This section consists of a medical director, an assistant (both of whom are graduate flight surgeons), and especially qualified designated doctors throughout the country. These physicians examine pilots and student pilots as to their physical and mental fitness for flying before they are licensed, and check those who are already licensed by periodic examinations.

The work of this section, too, during the past year has increased beyond all anticipation, the amount of work being approximately two and a half times as great as in the preceding fiscal year.

The number of physical examinations certified increased from 11,688 during 1927-28 to 28,153 during 1928-29.

Comparative figures are given for the two years.

	1927-28	1928-29
Original examinations, trained pilots.....	6,567	13,709
Reexaminations, trained pilots.....	1,242	8,013
Student pilots, original examinations.....	4,379	16,756
Total.....	12,188	
Deduct 500 for 1926-27.....	500	
Total.....	11,688	28,478

Although it would appear from these figures that the number of trained pilots is decreasing, very opposite is the case. Practically all those who received training other than as licensed students have now been taken care of, and the trained pilot class is coming to-day from the student class. Inasmuch as their student examinations are their original examinations, their numbers do not appear under "trained pilots, original examinations," but under "students." Their first examinations as trained pilots, therefore, appear under "reexaminations." It will be seen from the accompanying figures that the number of examinations under these headings is rapidly increasing.

That there is a steady increase in the incoming examinations is shown by the following table. Comparative figures are given for two years. Figures are given by quarters and to the nearest 100.

	1927-28	1928-29
First quarter.....	1,700	6,500
Second quarter.....	2,100	5,700
Third quarter.....	2,400	7,000
Fourth quarter.....	4,500	9,000

The number of examinations during the first quarter of this fiscal year was half as large again as the last quarter of the preceding fiscal year; and the number in the last quarter of this year was twice as large as the number at the corresponding period last year. Furthermore, this figure of 9,000 does not include about 2,500 examinations received during the last year which were not checked because of lack of personnel.

From present indications the number of physical examinations during the first quarter of the new fiscal year just beginning will be nearly 12,000, which means that during the year 1929-30 we shall have 45,000 to 50,000 or nearly twice as many as in the fiscal year just ended.

In addition to the above examinations, there have been 1,200 rechecked and certified for a higher grade on the same examination.

Each examination has had to be checked and the results certified to the licensing section. In case of trained pilots, contact was made with the inspector in 600 separate cases to determine the advisability of granting waivers.

The number of medical examiners has increased from 366 on July 1, 1928, to 704 on June 30, 1929; and it is quite likely that this number will reach 1,000 by the end of the next fiscal year. This

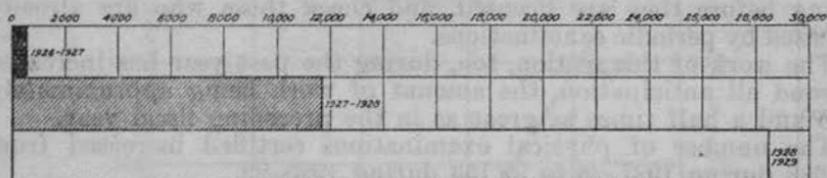


FIGURE 5.—Physical examinations received

means constant correspondence between this office and a constantly growing number of physicians, for about three physicians are usually corresponded with for every appointment made.

The personnel of the office has increased during the past year from 1 medical director and 4 clerks to 1 medical director, 1 assistant medical director, and 6 clerks. In other words, although the work has increased 250 per cent the personnel has increased only 50 per cent. As the rate of incoming work is constantly increasing, it will be seen that unless there is a corresponding increase in personnel the work of licensing pilots will be greatly delayed. It is estimated that four more clerks are needed to handle the immediate situation adequately. Every unnecessary step has been eliminated from the work, and only the barest essentials are being covered. Additional personnel would also obviate the present necessity of neglecting much valuable research.

One of the most important factors of the work is the coordination of the activities of over 700 medical examiners. It is essential that these physical examinations be standard. While definite standardized instructions are always issued, the technique should be inspected from time to time and frequent personal contact maintained. Since it is necessary that either the medical director or the assistant medical director be in Washington all the time, it would require

about three years for the other one to visit and inspect the work of every medical examiner.

Despite the fact that the medical examiner personnel is already too large to be efficiently coordinated directly from this office, it is constantly growing larger. For maximum results the country should be divided into five districts and a district flight surgeon appointed for each.

The duties of each of these district flight surgeons would be to interview all applicants for appointment in his district, and to co-

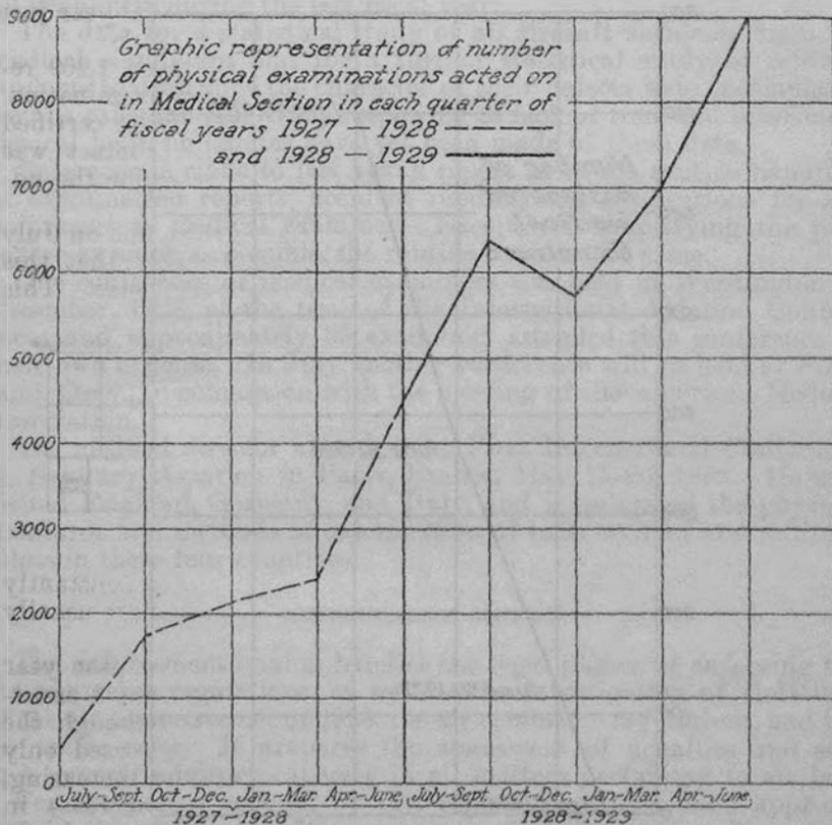


FIGURE 6

ordinate the work of examiners already appointed by personal interview and instruction. Later, if the country is districted also for licensing purposes, this district flight surgeon could handle the checking of the physical examinations for that district. It is believed that his duties at first would require only half time. The activities of these district flight surgeons could be frequently and easily checked by this office, which would inevitably result in a higher and more standardized type of examination.

No further appointments of medical examiners should be made without a personal interview and instruction, except in emergency.

This was the system in vogue at the start, but it was discontinued because of the necessity of the medical director being in Washington most of the time. With an assistant medical director it will be possible for one or the other to spend some time in the field, but the appointment of district flight surgeons will aid materially in this work. It is believed that all applicants in a given State should be gathered at one point for instruction and inspection. Recent appointees who have not had this instruction could also attend this instruction period.

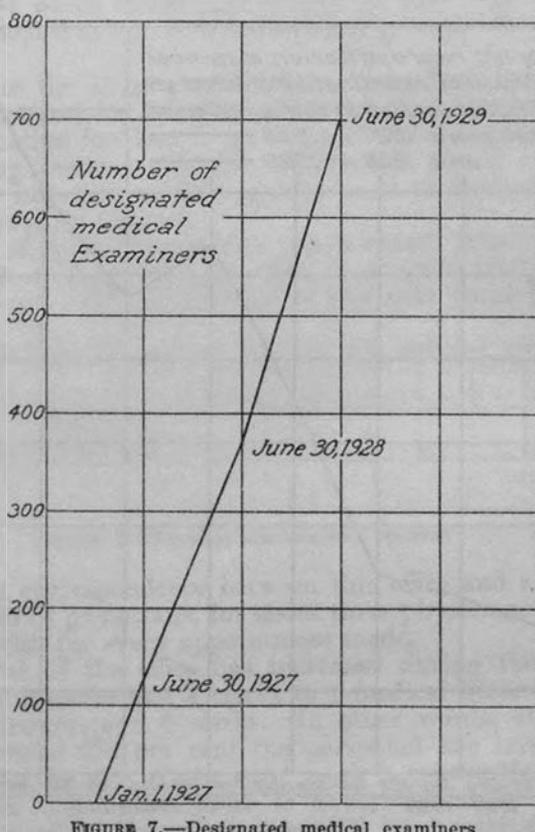


FIGURE 7.—Designated medical examiners

The appointment of these district flight surgeons would relieve this office of much routine work and thereby allow other things to be done which are now being neglected. Much statistical work, for example, should be done on the more than 40,000 examinations now on file to see whether or not present methods of examination and policy of granting waivers, etc., have proved practical from the standpoints of instruction, inspection, and actual flying ability of pilot applicants. Moreover, a closer study should be made of accidents from the physical standpoint.

Although more responsibility has been thrown on the medical examiners this past year by permitting them to issue letters of authority to student pilots, this responsibility will be further increased this year by permitting them to issue the actual student permits. While this will relieve the licensing section of a considerable amount of work, it will not reduce the volume of work of the medical section, as all the examinations and applications of students will still have to be checked and certified in this office.

Revised editions of the Physical Standards for Airplane Pilots and Supplementary Guide for Medical Examiners were sent out to all examiners during the last fiscal year.

The data for a statistical study of all aircraft accidents from the medical standpoint and for a further statistical study of rejected students to determine the character of their defects were accumulated for the calendar year 1928, but, owing to lack of time and insufficient clerical help, no studies have yet been made of these data.

Reference is made to last year's report as to the routine handling of examination reports, accident reports, and applications for appointment as medical examiner. Except for simplifying the procedure as much as possible, the routine remains the same.

One conference of medical examiners was held in Washington in December, 1928, at the time of the International Aviation Conference; and approximately 35 examiners attended this conference at their own expense. In July another conference will be held at Portland, Oreg., in connection with the meeting of the American Medical Association.

The medical director attended the First International Conference on Sanitary Aviation in Paris, France, May 15-20, 1929. He also visited England, Germany, and Italy, and investigated the physical standards and methods of examination of both civilian and military pilots in these four countries.

ENFORCEMENT SECTION

The enforcement section handles the legal phases of enforcing the air commerce regulations, as well as the investigation of violations of the air commerce act of 1926, the air commerce regulations, and the air traffic rules. It prepares the assessment of penalties and acts in a general advisory capacity in all matters pertaining to air law.

For the period covered by this report there have been approximately 493 violations, 176 assessments of civil penalties, 76 suspensions of licenses, 21 revocations of licenses, 6 denials of licenses, 192 reprimands, \$4,525 collected, 6 public hearings, and 12 cases referred to the Department of Justice.

While the total number of violations is more than twice that of the preceding year, the number of planes and hours flown has increased at a far greater rate.

Numerous complaints have been received alleging low flying over congested areas, but investigations have generally disclosed that no violations were committed, the low flying being accounted for by reason of take-offs and landings. A number of new airports and

landing fields have been established close to congested areas, which of course necessitates low flying over such places when taking off and landing.

During the past year, especially during January, February, and March, the enforcement section assisted in the preparation of State legislation covering aeronautics, passed upon State bills proposed on this subject, and advised State, municipal, and other authorities, both verbally and by correspondence, in the endeavor to assure urgently needed enactment of uniform State aeronautical legislation.

Numerous interpretations of the regulations were rendered, and the amendments to the regulations submitted during the year were compiled for publication.

ACCIDENT BOARD

The Aircraft Accident Board determines the causes of all aircraft accidents. This board consists of at least two expert pilots, a flight surgeon, an aeronautical engineer, a lawyer versed in air law, and a statistician, thus assuring that any contributing factor to an aircraft accident will be covered by expert knowledge. The board analyzes all accidents on which reports are received from the field and reduces them to their causation factors expressed in percentage. The statistics gathered from the work of this accident analysis have proved invaluable as a running check against the efficacy of the various functions of air regulation, showing exactly the points that must be stressed from time to time to decrease the number of aircraft accidents.

These accident-figure analyses have pointed the way to the development of certain engineering functions within the division which have already greatly decreased aircraft accidents due to structural failure and to unfavorable flying characteristics of the plane. They have also pointed the way to decreasing those accidents that are attributable to personnel, which are by far the greatest in number, and it is expected that the recently instituted system of rating flying schools and the new methods of licensing the higher passenger-carrying grades of pilots will go far toward decreasing the accident rate.

TABLE B.—Fatalities in airway operations and airplane miles per fatality, calendar years 1918-1929

FATALITIES IN AIRWAY OPERATIONS

Calendar year	Post-office mail			Contract mail			Other airway operations		
	Miles ¹	Fatalities		Miles ²	Fatalities		Miles	Fatalities	
		Pilots	Passengers		Pilots	Passengers		Pilots	Passengers
1929 (6 months).....	(3)	(3)	(3)	5,379,776	6	0	(3)	3	7
1928.....	(3)	(3)	(3)	7,846,296	7	9	2,827,154	2	4
1927.....	1,320,435	1	0	4,223,142	5	1	148,076	0	0
1926.....	2,583,056	1	0	1,958,144	3	1	77,680	0	0
1925.....	2,521,758	1	0	(5)	(5)	(5)	(5)	(5)	(5)
1924.....	2,161,077	3	0	(5)	(5)	(5)	(5)	(5)	(5)
1923.....	1,870,422	5	1	(5)	(5)	(5)	(5)	(5)	(5)
1922.....	1,756,803	1	0	(5)	(5)	(5)	(5)	(5)	(5)
1921.....	1,912,733	7	2	(5)	(5)	(5)	(5)	(5)	(5)
1920.....	1,048,444	8	6	(5)	(5)	(5)	(5)	(5)	(5)
1919.....	461,295	4	0	(5)	(5)	(5)	(5)	(5)	(5)
1918.....	102,548	1	0	(5)	(5)	(5)	(5)	(5)	(5)
Total.....	15,738,571	32	9	20,407,568	21	11	3,052,910	5	1

AIRPLANE MILES PER PILOT FATALITY

Calendar year	Post-office mail	Contract mail	Other airway operations
1929.....	(3)	1,063,296	(3)
1928.....	(3)	1,120,618	1,413,677
1927.....	1,320,435	844,628	-----
1926.....	2,583,056	652,715	-----
1925.....	2,521,758	(3)	-----
1924.....	720,350	(3)	-----
1923.....	374,694	(3)	-----
1922.....	1,756,803	(3)	-----
1921.....	273,248	(3)	-----
1920.....	131,066	(3)	-----
1919.....	115,324	(3)	-----
1918.....	102,548	(3)	-----

¹ Miles flown both in scheduled operations and in ferry, test, and other nonscheduled flights.

² Miles flown in scheduled operations, not including ferry test or other nonscheduled flights.

³ On July 1 and Sept. 1, 1927, the Post Office Department turned over their operations to private contractors.

⁴ No complete data available at this time.

⁵ No contract mail prior to 1926 save for the 2 foreign routes from New Orleans and Seattle. No casualties on either of these.

⁶ From 1911 to 1925 there have existed from time to time passenger lines between various points in the United States, but there is no official record of their operations.

GENERAL

The work of reorganization, in order to meet the new and ever increasing demands of the aircraft industry, has been carried on during the past year and is still in process. The engineering and inspection sections have been almost completely reorganized; and the licensing section is working out a new method of issuing licenses for both personnel and aircraft, as well as a much improved system of internal office procedure.

The problem of licensing aircraft to be used exclusively for experimental purposes has been cared for, and a new classification of "Restricted" (R) license created to cover special cases.

Requirements for transport pilots, mechanics, and airplanes have also been made more stringent.

A new airplane license system has been initiated providing for the issuance of licenses to aircraft which are subject to lien or chattel mortgage. This is a matter of immediate concern to aircraft manufacturers, operators, and finance companies, since it will probably be necessary to finance the marketing of aircraft in the very near future. Since a number of aircraft manufacturers are already selling their product on time payments, the inauguration of this system was a necessity and will be, of course, of material assistance to the industry.

Another of the many new problems which have arisen during the past year is that in connection with the expansion of American owned and operated air lines into foreign countries (Central and South America), and the desirability of maintaining both aircraft and airmen on an American licensed status. This has been partially solved by the establishment of inspection facilities in the Panama Canal Zone, but a more extensive service is immediately imperative if the Federal guaranty of airworthiness of aircraft, competency of personnel, and accompanying public confidence are to be maintained. The Alaska Territory is still uncared for except by a very brief yearly inspection, which is insufficient. The Hawaiian Islands are covered through arrangements with the Army, but there is not as yet representation in the Philippines.

The demand for particular and statistical information contained in the files of the division became so heavy during the year that it was extremely difficult to cope with the situation with the clerical force available. Arrangements were consequently made with the Aeronautical Chamber of Commerce and the American Bureau of Aircraft to develop and publish certain classes of this information. This arrangement has proved quite satisfactory and has provided the industry with a service that would not be possible for the department to render without a material increase in personnel.

In general, progress and development of the air regulations division during the past fiscal year is viewed with considerable satisfaction. Smoother functional efficiency has been obtained through improved sectional organization and coordination of sections and through better liaison with other divisions and with the aeronautic industry.

The reorganization accomplished has resulted not only in better service to the industry but a guaranty to the public of higher standards of airworthiness in approved aircraft and competence in licensed pilots. The process, however, is by no means completed. Because the division is in direct Federal control of the aircraft industry and operators, it will of necessity undergo continuous reorganization. It must, therefore, remain in a state of flux so long as that condition exists in the industry in order that it may not become unduly restrictive, but at the same time enforce suitable standards of safety.

As the new and increased demands placed upon the division by the industry have not been met by a proportionate increase in personnel, it can safely be said that the difficulties now being experienced in its efforts to give adequate service are not due to method but to the tremendous increase in volume of work and limited per-

Los Angeles-San Francisco.....	378	10	8	188	23.5	46	5.7	701.3	87.6	5,234.00	7.46	34	5.33	4	.33	4	3	4	1	-----	5	2	2	
San Francisco-Seattle (San Francisco-Redding and Portland-Seattle).....	367	11	4	100	25.0	26	6.5	304.0	76.0	1,724.00	5.67	33	5.29	1	1.00	5	12	2	1	-----	15	2	2	
Albuquerque-Wichita (Albuquerque-Clovis and Waynoka-Wichita).....	305	4	3	112	37.3	7	2.3	765.0	255.0	82.00	.10	22	1.05	15	.67	0	0	0	0	-----	0	2	2	
Total.....	10,183	120	263	6,300	24.0	1,455	5.5	19,677.3	74.8	95,750.87	4.87	881	10.86	518	5.13	45	110	54	27	7	8	320	72	85

¹ All airports are established, maintained, and operated through public or private enterprise and not by the Federal Government.

² The totals for airports, weather stations, radio stations, as shown are not the totals of the figures given, as one unit frequently serves two or more airways and is listed two or more times.

³ One radio communication station and one radiobeacon are located at Key West, Fla., providing service on the Key West-Habana Airway, which is not listed.

⁴ The totals for airway mechanics and service trucks as shown are not the totals of the figures listed, as there are relief mechanics, chief mechanics, and spare service trucks not definitely assigned to specific airways.

TABLE C.—Aids to air navigation—Continued
UNDER CONSTRUCTION

Airway	Miles lighted	Intermedi- ate fields	Beacons	
			24-inch revolving	Flashing
			Number	Number
St. Louis-Evansville.....	162	4	15	0
Milwaukee-Green Bay (Milwaukee-Fond du Lac).....	63	1	5	0
Atlanta-Chicago (Atlanta-Evansville).....	375	8	35	1
Michigan Airways (Kalamazoo-Detroit-Bay City).....	213	0	13	0
Cleveland-Albany (Buffalo-Albany).....	261	5	22	0
New York-Montreal (New York-Albany).....	142	3	12	1
Salt Lake-Pasco (Salt Lake-Burley).....	178	4	12	8
San Francisco-Seattle (Redding-Portland).....	400	11	43	17
St. Louis-Columbus (Indianapolis-Dayton).....	135	0	10	0
Los Angeles-Albuquerque (Gallup-Albuquerque).....	136	1	11	4
Total.....	2,065	37	178	31

AIRWAYS DIVISION (BUREAU OF LIGHTHOUSES)

The work of the airways division is carried on under the laws, rules, and regulations applicable to the Lighthouse Establishment, and so far as practicable through the regular district organization of the Lighthouse Service.

This division is under a chief engineer and is organized into four units—surveys, construction, weather and communications, and radio.

The survey unit determines airway routings, selects sites for beacons and landing fields, and concludes all negotiations for licensing these sites and for conditioning the fields for use by aircraft. The construction unit arranges for the purchase and shipment of all lighting equipment and supervises its erection and installation under contract or by airways division field forces. The weather and communications unit selects, establishes, and supervises the operations of airways weather-reporting stations and airways-communication stations. The radio unit designs, procures, and supervises the erection and installation of radio equipment for communications stations and radiobeacons.

Maintenance of the intermediate landing fields and beacon lights is accomplished by the district organizations of the Lighthouse Bureau to which have been added the necessary special personnel. Maintenance of aeronautical aids has been assigned as follows:

Third lighthouse district, Staten Island, N. Y.:	Sixth lighthouse district, etc.—Con.
New York-Boston airway.	Miami-Atlanta airway (Jacksonville-Atlanta section).
Chicago-New York airway (Bellefonte-New York section).	New Orleans-Atlanta airway (Selma (Ala.)-Atlanta section).
Atlanta-New York airway (Richmond-New York section).	Atlanta-Chicago airway (Atlanta-Evansville section).
New York-Montreal airway.	Tenth lighthouse district, Buffalo, N. Y.:
Sixth lighthouse district, Charleston, S. C.:	Chicago-New York airway (Bryan (Ohio)-Bellefonte section).
Atlanta-New York airway (Atlanta-Richmond section).	Louisville-Cleveland airway.

Tenth lighthouse district, etc.—Con.
 Cleveland-Detroit airway.
 Cleveland-Albany airway.
 Cincinnati-Chicago airway (Cincinnati-Indianapolis section).
 St. Louis-Columbus airway (Indianapolis-Dayton section).
 Washington-Cleveland airway (Pittsburgh-Cleveland section).
 Twelfth lighthouse district, Milwaukee, Wis.:
 Chicago-Twin Cities airway.
 Chicago-New York airway (Chicago-Bryan section).
 Cincinnati-Chicago airway (Indianapolis-Chicago section).
 Atlanta-Chicago airway (Evansville-Chicago section).
 St. Louis-Chicago airway.
 Kansas City-Chicago airway.

Twelfth lighthouse district, etc.—Con.
 Omaha-Chicago airway.
 Kansas City-Omaha airway.
 Kansas City-St. Louis airway.
 St. Louis-Evansville airway.
 Milwaukee-Green Bay airway.
 Michigan airways.
 Seventeenth lighthouse district, Portland, Oreg.: San Francisco-Seattle airway (Medford-Seattle section).
 Eighteenth lighthouse district, San Francisco, Calif.:
 Los Angeles-Salt Lake City airway (Los Angeles-Las Vegas section).
 Los Angeles-San Francisco airway.
 San Francisco-Seattle airway (San Francisco-Medford section).
 San Francisco-Salt Lake City airway (San Francisco-Reno section).

Only two maintenance organizations, in addition to the regular lighthouse districts, have been required to maintain efficiently the airways extending from the Mississippi and Missouri River Valleys to the eastern borders of California, Oregon, and Washington. These have been located at Salt Lake City, Utah, and Fort Worth, Tex., in charge of airways engineers and are concerned solely with the maintenance of aeronautical aids. Airways maintenance has been assigned to these offices as follows:

Airways engineer, Fort Worth, Tex.:
 Dallas-Kansas City airway.
 Tulsa-Ponca City airway.
 Los Angeles-Albuquerque airway (Gallup-Albuquerque section).
 Albuquerque-Wichita airway.
 Waco-Fort Worth airway.
 Airways engineer, Salt Lake City, Utah:
 Salt Lake City-Omaha airway.
 Salt Lake City-Great Falls airway.

Airways engineer, Salt Lake City, Utah—Continued.
 Salt Lake City-Pasco airway.
 San Francisco-Salt Lake City airway (Reno-Salt Lake City section).
 Los Angeles-Salt Lake City airway (Las Vegas-Salt Lake City section).
 Pueblo-Cheyenne airway.

The divisions of finance, law and property, and personnel of the Bureau of Lighthouses function in their respective spheres of action for the airways division, thus obviating the necessity for special units.

NAVIGATION FACILITIES ON CIVIL AIRWAYS

The 1929 appropriation of \$4,689,550 was expended for the establishment of aids on 4,266 miles of airways. Seventeen airways were included in this mileage, on all of which air transport companies are operating on regular schedules requiring night flying all or part of the time over the entire airway or the section lighted. These airways are: Cincinnati-Chicago, Kansas City-Omaha, South Bend-Kalamazoo, Chicago-Twin Cities (La Crosse-Twin Cities section), Cleveland-Albany, Miami-Atlanta (Jacksonville-Atlanta section), Salt Lake-Pasco (Salt Lake City-Boise section), Kansas City-St. Louis, St. Louis-Evansville, San Francisco-Seattle (Redding-Seattle section), Atlanta-Chicago, New York-Montreal (New York-Albany section), Michigan airways, Milwaukee-Green Bay (Milwaukee-Fond du Lac section), St. Louis-Columbus (Indianapolis-Dayton

there were under contract with the work of installation in various stages of completion 2,065 miles of airways on which are being established 37 intermediate fields and 209 airway beacons. The 2,065 miles under construction include:

New York-Montreal (New York-Albany section).
 Cleveland-Albany (Buffalo-Albany section).
 Michigan Airways (Kalamazoo-Detroit-Bay City sections).
 Atlanta-Chicago (Atlanta-Evansville section).
 Milwaukee-Green Bay (Milwaukee-Fond du Lac section).

St. Louis-Evansville.
 Salt Lake-Pasco (Salt Lake-Burley section).
 San Francisco-Seattle (Redding-Portland section).
 St. Louis-Columbus (Indianapolis-Dayton section).
 Los Angeles-Albuquerque (Gallup-Albuquerque section).

Surveys of the following airways for lighting in the fiscal year 1930 were under way in June, 1929: Miami to Atlanta (Miami-Jacksonville section), Washington to Cleveland (Washington-Pittsburgh section), Brownsville-New Orleans (Brownsville-Houston section), Brownsville-Fort Worth (Waco-Fort Worth section), Portland to Pasco, Pasco to Spokane.

TABLE D.—Scheduled flying on civil airways, calendar year 1928

Operator	Route	Months operated	Miles flown ¹	Passengers flown	Express (pounds)	Mail (pounds)	Mail payments
Ball	Pittsburgh-Cleveland	12	82,061	209	2,146	66,817	\$200,452.21
Barnes and Gorst ²	Seattle-Victoria	12	22,715	305	0	58,843	24,430.00
Boeing	San Francisco-Chicago	12	1,817,899	1,963	24,089	986,162	2,016,654.81
Braniff	Tulsa-Oklahoma City	6	104,000	2,695	0	0	0
	Wichita-Oklahoma City	(³)	(³)	(³)	0	0	0
	Tulsa-Oklmulgee	(³)	(³)	(³)	0	0	0
Canadian-Colonial	New York-Montreal	3	40,806	119	0	\$22,103	\$23,061.00
Colonial	New York-Boston	12	121,127	106	1,950	55,742	106,966.84
Colonial Western	Cleveland-Albany	12	204,847	243	243	52,988	58,815.00
Commercial	Seattle-Vancouver	3 ¹ / ₂	3,500	48	0	0	0
Continental	Louisville-Cleveland	5	168,535	27	0	28,285	34,508.41
Embry-Riddle	Cincinnati-Chicago	12	183,438	814	671	41,098	60,401.42
Ford Motor	Detroit-Chicago	12	290,517	(⁴)	1,631,512	9,758	10,499.63
	Detroit-Cleveland	12	(⁴)	(⁴)	(⁴)	1,160	1,250.63
	Detroit-Buffalo	12	(⁴)	(⁴)	(⁴)	0	0
Gulf Air Lines	New Orleans-Atlanta	8	207,699	349	0	27,677	48,432.77
Interstate	Atlanta-Chicago	1 ¹ / ₂	46,998	127	0	8,850	6,900.28
	St. Louis-Evansville	1	(⁵)	(⁵)	0	(⁵)	(⁵)
Maddux	Los Angeles-San Francisco	8 ¹ / ₂	266,996	11,118	0	0	0
	Agua Caliente-San Diego	5	(⁶)	(⁶)	0	0	0
	San Diego-Palm Springs	13 ¹ / ₂	(⁶)	(⁶)	0	0	0
	San Diego-Los Angeles	6	(⁶)	(⁶)	0	0	0
Midwest	Waterloo-Des Moines	13 ¹ / ₂	4,600	68	35	0	0
Mutual ⁷	Los Angeles-Oakland	6	106,175	50	95,135	0	0
National ⁸	Chicago-New York	12	2,682,602	1,260	68,190	969,049	910,913.61
	Dallas-Chicago	12	(⁹)	(⁹)	(⁹)	226,636	678,063.29
National Parks	Salt Lake City-Great Falls	5	165,324	450	0	23,871	59,682.03
New Orleans	Pilotown-New Orleans	12	60,610	0	0	80,976	33,549.00
Northwest	Chicago-Twin Cities	12	299,520	967	0	71,100	195,524.04
	Milwaukee-Green Bay	3 ¹ / ₂	(¹⁰)	(¹⁰)	0	0	(¹⁰)
Universal ¹⁰	Chicago-Cleveland	3 ¹ / ₂	173,233	752	0	0	0
Northern Air Lines ¹⁰	Chicago-Twin Cities	5	(¹¹)	(¹¹)	0	0	0
	Twin Cities-Fargo	(¹¹)	(¹¹)	(¹¹)	0	0	0
	Twin Cities-Duluth	(¹¹)	(¹¹)	(¹¹)	0	0	0

¹ Miles flown include schedule, ferry, and test, but do not include miles flown on miscellaneous operations.

² Operated first half of 1928 by the Northwest Air Service.

³ No report.

⁴ Included in total of operator.

⁵ Does not include mail carried or revenue from mail carried under contract with other Governments.

⁶ Cleveland-Buffalo only for first 5 months.

⁷ Evansville-Chicago section inaugurated Nov. 19, 1928.

⁸ No report for first half of 1928.

⁹ Includes Tulsa-Ponca City spur inaugurated also July 5, 1928. Toledo-Detroit spur inaugurated June 4, 1928.

¹⁰ Northern Air Lines and Universal submitted a consolidated report.

TABLE D.—Scheduled flying on civil airways, calendar year 1928—Continued

Operator	Route	Months operated	Miles flown	Passengers flown	Express (pounds)	Mail (pounds)	Mail payments
Pacific Air Transport	Los Angeles-Seattle.....	12	702,739	1,482	3,296	137,664	\$389,740.27
Pan American.....	Havana-Miami.....	12	145,580	1,401	6,240	345,726	146,363.00
Pittcairn.....	Atlanta-New York.....	7	431,608	0	0	106,623	319,981.42
	Miami-Atlanta.....	1	(¹)	0	0	4,841	6,993.95
Robertson.....	St. Louis-Chicago.....	12	243,865	5,710	0	63,489	160,702.63
Standard.....	Los Angeles-Tucson.....	12	156,000	1,063	336	0	0
Spokane.....	Walla Walla-Spokane.....	3	10,800	218	0	0	0
Stout Air Service.....	Detroit-Chicago ¹¹	2	60,751	6,412	500	0	0
	Detroit-Cleveland ¹²	12	(¹)	(¹)	(¹)	0	0
Texas Air Transport.....	Laredo-Dallas.....	11	445,519	926	9	42,842	123,770.21
	Galveston-Dallas.....	11	(¹)	(¹)	(¹)	29,216	84,433.56
Thompson.....	Chicago-Bay City.....	5½	166,876	(¹)	0	70,167	62,447.27
West Coast.....	San Francisco-Portland.....	6	350,000	5,081	250	0	0
	Portland-Seattle.....	6	(¹)	(¹)	(¹)	0	0
United States.....	Washington-New York.....	6½	27,200	238	0	0	0
Varney.....	St. Louis-Pasco.....	12	378,853	0	0	133,348	400,032.16
Western Air.....	Los Angeles-Salt Lake City.....	12	950,552	5,630	13,598	385,924	1,156,654.28
	Los Angeles-San Francisco.....	7	(¹)	(¹)	(¹)	0	0
	Pueblo-Cheyenne.....	12	(¹)	(¹)	(¹)	62,818	52,138.94
	Wilmington-Avalon.....	12	(¹)	(¹)	(¹)	0	0
Total.....			10,673,450	49,713	1,848,156	4,063,173	7,432,720.86

¹ No report.² Included in total of operator.³ Does not include mail carried or revenue from mail carried under contract with other Governments.¹¹ Discontinued July 19, 1928.¹² Mail contract discontinued July 16, 1928, but route is still operated for the carrying of express by the Ford Motor Co.

ENGINEERING LAYOUT OF AIRWAYS

Between the given terminals or intermediate airports airways are laid out on as near straight lines as the topographical features of the region will permit. A strip approximately 25 miles wide is carefully studied from the air to determine the location of the most level open country, the wooded and mountainous sections (to be avoided, if possible), the location of main roads, railroads (both important landmarks for day flying), centers of habitation, and electric-power lines. At the same time a survey is made to determine the proper locations for radiobeacons. These studies are supplemented by a ground survey for corroboration of and additions to the data obtained from the aerial survey and the straightest route which offers the best combination of the facilities mentioned is selected. On the route adopted intermediate field sites at approximately 30-mile intervals are selected, with due regard for the fact that fields to be useful in emergencies should be located on good roads near centers of habitation where help is available and where facilities for prompt communication and transport exist. The exceptions to this plan may be noted in hazardous territory where additional fields are located at critical points, in which cases the possibility of negotiating safe landings largely precludes other considerations.

On an air line between the fields, at approximate 10-mile intervals, beacon sites are selected. Beacon sites vary slightly from standard line and spacing in order to secure advantages of roadside location and commercial electric power, and also to secure for the sites the advantage of as high an elevation as practical, so that interven-

ing ground elevations may not block the view from one beacon to the next. When the topography is such that this is impossible, elevations between adjacent regular beacons are marked with auxiliary beacons or blinkers of lower candlepower, so that light-to-light vision may always be maintained unless atmospheric conditions prevent.

When licenses for the occupation of fields and beacon sites have been secured a survey is made of each field site to determine the kind and amount of conditioning that is required to make it suitable for airplane use and the necessary work is performed under contract.

Upon receipt of the necessary data a proposal is prepared and contract let for installation of the lighting equipment on the airway as a whole or in sections, after accomplishment of which the airway is assigned to one of the districts for maintenance.

During the construction period a survey is made in collaboration with representatives of the Weather Bureau to determine the proper locations for weather reporting and communication stations which are established approximately coincident with the placing in operation of the lighting facilities.

Airways are designated by the first letters of their terminal cities, thus, O-C for Omaha to Chicago, LA-SF for Los Angeles to San Francisco. All field and standard beacon sites are known by numbers which, by the addition of zero, indicate their approximate mileage on the airway; thus, a field 32 miles from the starting point of an airway is No. 3; a beacon 585 miles from the starting point is No. 58. Beacons other than standard are given numbers corresponding exactly to their mileage.

At the close of the fiscal year 1929, 13 experienced airplane pilots, 10 civil engineers, and 5 airplanes were assigned to the survey of airways. Four electrical and structural engineers and 18 inspectors of airways construction, all of them with extensive aeronautical experience, were engaged in the establishment of lighting equipment.

INTERMEDIATE FIELDS

The standard intermediate field in low altitudes provides two landing strips or runways of a length of 2,000 feet and width of 600 feet, approximately at right angles to each other, with one strip lying in the direction of the prevailing wind. Such a field has an area of 47 acres. In the higher altitudes (above 4,000 feet) the standard length for landing strips is 2,500 to 3,000 feet. Landing strips may form a T, L, or \oplus , and the inner angles at the junctions of the strips are usually beveled off to provide additional diagonal landing space for use under conditions of strong cross winds. In many cases it is possible to secure triangular or square fields giving the desired runway lengths in all directions. In rough country it is often possible to secure only one landing strip, in which case an attempt is made to increase the width of such a "2-way field" sufficiently to permit landing diagonally into strong cross winds.

The field surfaces should be fairly level, and when not level must be free from sharp breaks in grade, and well drained, naturally or by artificial methods.

Fields are licensed for occupation for periods of 5 to 10 years, with occupation for an indefinite period beyond this term subject to

termination upon six months' notice by either party. The average cost is \$4.87 per acre per annum throughout the United States. Beacon sites are similarly licensed, the average cost being \$3.37 per site per annum. Owing to the constantly increasing public interest in air transportation, it has been found possible to establish many intermediate fields on a cooperative basis, whereby the city or town at which the field is located, or some civic or commercial organization of the city, rents or purchases the field and licenses it to the department at a reduced or nominal consideration, or conditions the field licensed directly from the owner by the department, or both. A large portion of the intermediate fields established during the past year have been established cooperatively with considerable saving in expense to the Government.

INTERMEDIATE FIELD MARKING AND LIGHTING

Intermediate fields have been marked by 50-foot (diameter) white circles at the intersections of the runway center lines, with white panels 20 feet long and 2 feet wide extending from the outside of the circle along the runway center lines to indicate the landing directions. It is proposed to increase the size of these markers to a diameter of 100 feet for the circle with a 4-foot band and to a length of 100 feet and width 4 feet for the runway markers. The circle and panels are constructed of crushed rock tamped flush with the field surface and whitewashed. The boundaries of the fields are marked by chrome yellow sheet metal cones 30 inches in diameter and 24 inches in height, installed immediately below the boundary lights and attached to the boundary light standards. It is proposed to augment this boundary marking by installing 70-foot sections of painted fence at each angle in the field boundary and at 600-foot intervals on long straight sides.

The lighting of intermediate fields comprises a beacon, course lights, boundary lights, range lights, obstruction lights, and illuminated wind indicator. A standard 24-inch revolving beacon is provided at each field, with the exception that in mountainous territory, where fields lie off the air line marked by beacons or in valleys at irregular intervals between beacon sites, electric blinkers of lower candlepower are provided; and in desert or uninhabited regions, where commercial electricity is not available, nor supplies of gasoline and oil, and attendants to operate local electric generators can not be had, acetylene beacons, which may be charged up for a 6 months' period of operation without attention, are installed in lieu of standard electric equipment.

Standard boundary lights, installed at intervals of approximately 300 feet around the perimeters of the fields, consist of waterproof prismatic globes and fittings mounted on iron pipe standards 30 inches above the ground (where snowfall of greater depth is anticipated the height of standards is increased), in which are installed 15-watt electric bulbs if commercial current is available, or 10-watt bulbs if power is provided by a local generator. An underground parkway cable carries the current to the boundary lights.

Range lights, installed in the boundary system and similar in all respects to boundary lights, except that the wattage of the bulbs is

increased by 10, and that the clear globes are replaced by green globes, are placed at opposite ends of the principal runways to aid pilots in making landings. Two such range lights are used at each end of the best or prevailing-wind runway, and single lights mark the center line of the other runway.

Obstructions at the ends of landing strips or runways over which approaches or take-offs must be made are marked in all cases by red lights at the heights of such obstructions. Obstruction lights have 25-watt electric bulbs in lighthouse red globes. Where only a few isolated obstruction lights are necessary connection is made with the boundary light circuit. Where obstructions are in the nature of pole lines, or lines of trees, separate overhead electrical circuits are sometimes provided. Obstructions along the sides of runways, where the widths of runways do not permit of landing or taking off across them, are marked by red obstruction lights at obstruction height if isolated, or by obstruction lights at obstruction heights at the extremities of a line of obstructions, supplemented by red lights in the boundary light system between the extremities.

Desert fields are boundary lighted by special acetylene blinkers flashing one hundred times per minute, established at the corners of the fields and the centers of long sides. Range lights, obstruction lights, and illuminated wind indicators can not be provided, but in such cases all obstructions have been removed.

Illuminated wind indicators are supported on brackets attached to the beacon towers. A conventional wind cone or sock 8 feet long, 18 inches in diameter at the mouth, and 8 inches in diameter at the opposite end, of porous weave, is colored chrome yellow. A 150-watt electrical lamp is installed at the mouth with a chromium-plated reflector which directs the entire output of light into the sock. A skeleton metal framework extending inside for a distance of 4 feet holds this portion of the sock open and horizontal to increase the effectiveness of the lighting. This indicator shows wind direction at a wind velocity of 5 miles per hour. At greater velocities the sock inflates and rises proportionately, reaching an angle of 7° below the horizontal at a wind speed of 30 miles per hour.

At the close of the fiscal year 1929, 263 intermediate fields, equipped as described, were being maintained by the airways division. The average cost of the lighting installation is approximately \$5,000 per field.

BEACONS

Airway beacons have been established at approximate 10-mile intervals from airport to airport on all lighted airways. Every third beacon is on an intermediate field, according to standard practice. Alterations of the direction of airway courses generally occur at fields, and the beacons between fields are established as near as possible on the air line from field to field.

The standard beacon consists of a 1,000-watt searchlight fitted with a 24-inch precision parabolic mirror giving 2,000,000 beam candlepower. An electric motor of one-sixth horsepower rotates the searchlight at six revolutions per minute. Each beacon is fitted with an automatic lamp changer and two electric lamp bulbs. In case

one lamp burns out, the stand-by lamp is automatically placed in circuit and in focus within a fraction of a second. Two course lights are mounted on the tower platform just below each searchlight, one pointing forward and one pointing backward on the airway course. The course lights are 500-watt searchlight projectors fitted with special cylindro-spherical mirrors and 18-inch doublet lenses, giving a beam of 15° horizontal and 8° vertical spread with a beam candlepower of 100,000 when fitted with lighthouse red or green lenses. Red lenses are used at beacon sites and green lenses at intermediate landing fields. Each course light, in alternation (while the main beam of the beacon is swinging through the opposite 180° of arc), flashes its code signal, which corresponds to its number on the airway. Code signals run from 0 to 9 and then recommence. The pilot must know on which 100-mile section of airway he is flying in order to positively identify the site.

The beacon is mounted on a skeleton steel tower, the standard height of which is 51 feet. Towers of standard construction are, however, available in 20, 62, 75, and 87 foot heights for use where conditions indicate desirability of heights other than 51 feet. At the top of each tower is constructed a 6-foot square platform with guard railing, providing an opportunity for airway mechanics to work on the lights with ease and safety.

On the ground at each tower base is constructed in concrete a directional arrow 54 feet in length which points to the next higher numbered beacon. The tower rises in the center of the arrow. The arrow surface is painted black on the rectangular feather end. At all fields and at beacons where local generating sets are required a small power house 10 by 14 feet forms the feather end of the arrow. At fields which do not require local generators the houses provide storage facilities for emergency equipment.

Gasoline engine-driven electric-generating sets, where required, are furnished in duplicate, with a thermostatic relay control which will automatically stop the operating generator if it becomes too hot and will start the stand-by generator. Generators may thus alternate automatically throughout a night.

Astronomic time clocks are installed at all beacons connected with commercial power. These clocks switch on the current at sunset and switch it off at sunrise.

There is under service test a clock designed to operate on the direct current produced by the gasoline-engine-driven generators and automatically start and stop these at the proper time, which, if the test is successful, will permit full automatic operation of all electric installations.

Topographic considerations, in some instances, require closer spacing of lights and lighting of hazards to air navigation, such as mountains, buttes, or canyon walls. In desert regions it has in many cases been found impracticable to install electric beacons, due to the lack of possible caretakers and the difficulty of supplying local generators with gasoline and oil.

For use as auxiliary lights, or in lieu of standard beacons at standard spacings, the airways division has designed and installed other types of beacons which work effectively. Dioptric lanterns of 300 and 375 millimeters diameter have been used with single

acetylene burners, with clusters of three acetylene burners, and with 500-watt electric lamps. Another standard unit is a double-ended range lantern fitted with two 18-inch doublet lenses similar to the course light lenses using a double acetylene burner light source. When such units are used in lieu of standard beacons to mark the airway center line the standard spacing is reduced to $3\frac{1}{2}$ miles, by which arrangement the lower candlepower is offset by the shorter spacing, resulting in practically equivalent effectiveness.

There were 1,399 beacons of all types in operation at the close of the fiscal year 1929.

WEATHER SERVICE AND COMMUNICATIONS

During the fiscal year 1929 the United States Weather Bureau established 3 new upper air meteorological stations in addition to the 42 already existing. The majority of these are located at airports throughout the United States and furnish information at frequent intervals during the day and night to weather-control stations along the airways. Reports are also received from over 200 first-order Weather Bureau stations twice daily. These, in combination with the upper air reports, are used in making the zone forecasts for the airways. Such forecasts are made available to all pilots using the airway through the medium of airways communication stations.

The system of communications already established, under which the maintenance personnel on the airways furnishes to the Weather Bureau airways-control stations certain additional information regarding local storms, fogs, and changes in existing local weather conditions, is being constantly extended as new airways are established. There are at present 54 airways weather observers engaged in furnishing data to Weather Bureau personnel at terminal fields along the airways. In addition, the United States Weather Bureau has established 110 special airways weather reporting stations from which frequent daily reports of local conditions are obtained. This information is furnished to the control stations along the airway and transmitted to other stations in the immediate vicinity. Such information from control stations to other stations in the immediate vicinity or along the airway is transmitted by the communications network of the airway. During the fiscal year there were four complete meteorological stations established by the United States Weather Bureau.

Teletype circuits between weather reporting stations on the Chicago-New York and Los Angeles-San Francisco airways have been established and placed in operation, for transmission of hourly reports from the airways weather reporting stations, and will be continued in service through the fiscal year 1930.

Experience has shown that it is essential that weather reports for pilots should be furnished at more frequent intervals and a plan has been worked out which will be put in effect at the beginning of the fiscal year 1930. In accordance with this plan, a number of stations have been established from 150 to 200 miles on either side of the transcontinental airway and approximately the same distance apart. Reports will be received from each of these stations in three major

control stations at 3-hour intervals, day and night. A résumé of conditions in the geographical area surrounding each control station will be made by an official of the United States Weather Bureau. This résumé will be transmitted to all airways communications stations within the sector to be broadcast simultaneously by them.

It is planned also to broadcast from all airways communication stations by radiophone a report of the terminal weather from certain terminal fields within the geographical area surrounding each station. This broadcast will be made each half hour so that pilots may have first-hand information regarding the conditions at their destination. Constant improvement is being made in the weather reporting and communications system and it is expected that a nationwide broadcast of conditions at short intervals of time will soon be placed in operation.

RADIO EQUIPMENT

During the fiscal year 1929 the improvement and standardization of radio stations and radio equipment was most marked. The present standard radio communication comprises a 2-kilowatt intermediate frequency radio telephone and telegraph transmitter complete with motor generator, line amplifier, and two button microphones, operating on 100 to 500 kilocycles frequency, for broadcasting by voice or code to airplanes and ground stations; a 400-watt crystal controlled high-frequency radiotelegraph transmitter for point-to-point communication in code at 3,000 to 6,000 kilocycles; an intermediate frequency receiver (75 to 1,000 kilocycles); a high-frequency receiver (2,000 to 15,000 kilocycles); and a 2,300-watt engine driven generator for emergency power supply, with a 2,000-watt rotary converter, capable of furnishing current sufficient for radio transmission, station lights, and tower obstruction lights; all housed in a 22 by 28 foot ready-cut frame building of attractive design and construction. The intermediate frequency single wire antenna is supported on two 125-foot skeleton steel towers 380 feet apart equipped with winches. The high-frequency antenna system is mounted on one 50 and two 60 foot masts. The radio grounding system comprising approximately 4,000 feet of solid copper wire is buried.

During the past year 11 of these standard stations have been erected to replace the old stations on the transcontinental route equipped with obsolete arc type apparatus at Bellefonte, Cleveland, Maywood (Chicago), Iowa City, Omaha, North Platte, Rock Springs, Salt Lake City, Elko, Reno, and Oakland; and complete new standard apparatus has been installed in the city-owned radio building at Cheyenne and in the Commerce Department hangar at Bryan, Ohio. New stations have been established at Key West, La Crosse, St. Louis, North Kansas City, Wichita, Glendale, and Fresno. All these stations are transmitting scheduled radiotelephone broadcasts. Point-to-point radiotelegraph communications may, when required, be handled on the 2-kilowatt intermediate frequency transmitter, but are usually transmitted on the 400-watt high frequency set.

Four additional standard radio communication stations which are practically completed and will go into operation during the

month of August, 1929, are at Medford, and Portland, Oreg., Seattle, Wash., and Boston, Mass.

Seven radiotelegraph stations located in temporary quarters, but equipped with modern high-frequency equipment, are in operation at Oklahoma City, Forth Worth, Washington, D. C., Richmond, Greensboro, Spartanburg, and Atlanta.

Twenty-five 200-watt intermediate frequency combination telephone and telegraph transmitters are on order. It is expected that these transmitters will become standard at points where a transmission range of not more than 50 miles is required and as emergency equipment at standard communication stations.

The aural type radio-range beacon has been greatly improved and standardized. As now installed it consists of a 2-kilowatt aural type interlocking equi-signal transmitter with goniometer and automatic keying device operating in the 190 to 565 kilocycle range, housed in a single-room frame building and in several cases operated by remote control. The antenna system comprises two single-wire vertical loops installed at right angles to each other on five wooden masts. Seven standard beacons are now in operation at New Brunswick, Bellefonte, Cleveland, Goshen, Sterling, Des Moines, and Key West, Fla., providing a continuous radio-marked course from Omaha to New York and Key West to Habana. The Hadley Field radio-beacon also marks 100 miles each of the airways to Boston and Atlanta. At York, Gothenburg, and Boston, radiobeacons are being constructed which will complete the radio marking of the New York to Boston airway and extend the radio marking of the transcontinental route to Cheyenne, Wyo. Sixteen additional radiobeacons are expected to be in operation at the close of fiscal year 1930.

Radio-marker beacons are required to indicate the intersections of radio-range courses, and in some instances to indicate the locations of landing fields. The marker beacon comprises a 7.5-watt double-frequency automatic transmitter of an effective range of 3 to 5 miles, with a simple single-wire antenna supported on a single mast. Eight such marker beacons have been placed in operation at Numidia, Brookville, Toledo, Bryan, Lansing, Cicero, Aurora, and Iowa City.

In order to check up efficiently the operation of the radio equipment and to obtain data for use in increasing the efficiency of operation, two of the airways division airplanes have been fitted with the best modern airplane radio equipment, and are continually engaged in this work. Valuable data have been obtained thereby. In cooperation with other units of the Department of Commerce airways division radio engineers have been engaged in the development of a poly-directional radiobeacon which will furnish 12 radio-marked courses instead of the 4 now produced by the standard radiobeacon. These courses will normally be separated by intervals of 30°, but the angles of divergence are readily adjustable to meet requirements. The first such beacon is approaching completion at the Lighthouse Bureau depot in Detroit. Other development work includes the design of the 200-watt intermediate frequency combination telephone and telegraph receiver already mentioned, the automatic transmitting apparatus for marker beacons and a means of varying the angle of divergency between the radiobeacon courses by

introduction of a single-wire antenna into the close loop system in such a manner as to vary the loop field patterns.

The Federal Radio Commission has been induced to reserve 50 radio channels for airplane radio communication, and to make allotments of these channels to airways rather than to operating companies, thus providing for continuation of radio communication over specific airways in the same channel regardless of the changes in identity of operating concerns.

At the close of the fiscal year 1929, 6 radio engineers, 2 construction engineers, and 12 radio electricians were engaged in experimental work, construction of radio stations, and installation of apparatus.

MAINTENANCE OF AIRWAYS

Airway equipment, after installation by the airways division, is assigned to the Lighthouse Service district offices for maintenance. To these district offices are assigned associate and assistant airways engineers, of extensive aeronautical experience in addition to engineering qualifications, who, under the general supervision of the lighthouse superintendents, maintain the airways.

Airway mechanics are assigned to patrol 175-mile sections. They are provided with $\frac{1}{2}$ to $1\frac{1}{4}$ ton panel body motor trucks of the speedwagon type, equipped with spare parts and tools for taking care of practically any service or emergency repair job required on any type of airway lighting equipment. Airway mechanics must make their rounds and check over each beacon at least twice per month. Landing field caretakers are required to assist in any reasonable manner air travelers who make emergency landings on fields in their charge.

Caretakers are employed at all fields, and attendants at most beacons, whose duties include careful observation of the functioning of the lighting equipment and reporting to the airways mechanic of the district office any failures which can not be remedied by simple measures, such as changing lamp bulbs or fuse plugs.

At the close of the fiscal year 1929, 20 airways engineers, 72 airway mechanics, and 782 caretakers and attendants were employed in the maintenance of 10,183 miles of airways.

IMPROVEMENT IN AIRWAYS EQUIPMENT

Further refinements have been made in the design of the standard 24-inch revolving searchlight. A new type cover glass incorporating prisms which deflect 20 per cent of the light upward from the main beam and distributes it through 25° or vertical arc has been designed, service tested, and adopted as standard. This reduces the chances for a pilot to miss the beacon by flying above the main beam at short distances from the light. Mercury contactors for the course light circuits in the beacon base have been tested, approved, and adopted as standard, replacing the magnetic type which was objectionable on account of its interference with radio reception in the near vicinity.

A new type of stray light shield, in the form of a cylindro-spherical reflector, has been designed to replace the louvre type of shield.

This reflector is placed directly in front of the light source, gathering the stray light and reflecting it back through the parabolic mirror in such a manner as to increase the horizontal width of the main beam. It also shields the lamp bulb from the direct rays of the sun during daylight.

The illuminated wind indicator has been improved by providing for the installation of 150 or 200 watt bulbs instead of 75-watt bulbs. A skeleton frame or cage to be inserted in the wind sock holding it open and horizontal for half its length providing for greater visibility of the sock has been tested out and standardized. Several refinements in the design of beacon towers, including a steel grating for the platform and a cage for the ladder to be used on towers 100 feet or more in height, have been included in the new specifications. Beacons and fields supplied with commercial electric current are subject to failure as the result of transmission line breakdown due to electric storms or other causes at points at some distance from the sites. To provide against extinguishment of the lights at intermediate fields consideration is being given to the installation of a stand-by alternating current generator which can be automatically started upon failure of the commercial current and put the lights in operation again within a fraction of a minute. One such generator has been installed and is undergoing service test with satisfactory results during the limited period it has been in operation. A new signaling flare has been adopted as standard, which has double the burning time of the flare formerly used. An interesting device has been invented and is now under test which automatically causes the revolving searchlight to point north upon coming to a stop when the current is switched off at daylight. If it tests satisfactorily it will eliminate damage to the beacon lamps due to the reflection of the sun's rays from the parabolic mirror upon the lamp bulbs and sockets during the inoperative daylight period.

AIRWAYS STATUS

The following airways have been lighted and equipped with weather reporting service:

San Francisco-Salt Lake City.	Chicago-Twin Cities.
Salt Lake City-Omaha.	Kansas City-Chicago.
Omaha-Chicago.	Dallas-Kansas City.
Chicago-New York.	Tulsa-Ponca City.
New York-Boston.	Kansas City-St. Louis.
Atlanta-New York.	Kansas City-Omaha.
Atlanta-Chicago (Evansville-Chicago section).	Pueblo-Cheyenne.
Miami-Atlanta.	Los Angeles-Salt Lake City.
New Orleans-Atlanta (Selma (Ala.)-Atlanta section).	Salt Lake City-Pasco (Burley-Boise section).
Louisville-Cleveland.	Los Angeles-San Francisco.
Cleveland-Albany (Cleveland-Buffalo section).	San Francisco-Seattle (San Francisco-Redding and Portland-Seattle sections).
Cleveland-Detroit.	Albuquerque-Wichita (Albuquerque-Clovis and Waynoka-Wichita sections).
South Bend-Kalamazoo.	
Cincinnati-Chicago.	
St. Louis-Chicago.	

Installation is proceeding under contract on the following airways or sections:

New York-Montreal (New York-Albany section).	St. Louis-Evansville.
Cleveland-Albany (Buffalo-Albany section).	Salt Lake-Pasco (Salt Lake-Burley section).
Michigan airways (Kalamazoo-Detroit-Bay City sections).	San Francisco-Seattle (Redding-Portland section).
Atlanta-Chicago (Atlanta-Evansville section).	St. Louis-Columbus (Indianapolis-Dayton section).
Milwaukee-Green Bay (Milwaukee-Fond du Lac section).	Los Angeles-Albuquerque (Gallup-Albuquerque section).
	Waco-Fort Worth.

The department's program for the fiscal year 1930 contemplates establishment and maintenance of aids on the following additional routes:

Salt Lake City-Great Falls.	Galveston-Waco.
Portland, Oreg.-Pasco, Wash.	Miami-Jacksonville.
Pasco-Spokane.	Washington-Cleveland.
Brownsville, Tex.-New Orleans.	Jacksonville-Richmond.
Brownsville, Tex.-Fort Worth.	Fort Worth-Birmingham.

Airways under consideration for installation of aids subsequent to fiscal year 1930 include:

Tampa-Daytona.	El Paso-San Antonio.
Los Angeles-San Diego-Forth Worth.	San Antonio-Houston.
Los Angeles-Albuquerque.	El Paso-Pueblo.
Albuquerque-Wichita (to complete).	Fort Worth-Pueblo.
St. Louis-Indianapolis.	Kansas City-Minneapolis-Duluth.
Fort Worth-Louisville.	Seattle-Minneapolis.
New Orleans-St. Louis.	Fargo-Winnepeg.
New Orleans-Atlanta (to complete).	Washington-Buffalo.

The following airways have been fully equipped with radio communication service:

San Francisco-Salt Lake City.	Dallas-Kansas City.
Salt Lake City-Omaha.	Kansas City-Chicago.
Omaha-Chicago.	Chicago-Twin Cities.
Chicago-New York.	Los Angeles-San Francisco.
St. Louis-Chicago.	Atlanta-New York.

Radio construction is proceeding under contract to give service throughout the following airways:

New York-Boston.	San Francisco-Seattle.
Salt Lake-Pasco.	

Radiobeacon service has been provided on the Omaha-to-Chicago, Chicago-to-New York, and Key West-to-Habana airways, and radiobeacons are under construction to provide service on the Salt Lake-to-Omaha and New York-to-Boston airways.

DIVISION OF AIRPORTS AND AERONAUTIC INFORMATION

As the contact office between the Aeronautics Branch, the aeronautic industry, and the general public, the division of airports and aeronautic information is charged with virtually all of the promotion duties covered by the air commerce act of 1926. Specifically these duties include:

1. The direction and coordination of the work of the Aeronautics Branch related to the assisting in the selection and development of airports.
2. The promotion and correlation of cooperative scientific research with the industry on airport problems, and the publication of reports on these problems.

3. The promulgation of airport rating regulations and the rating of airports.
4. The publication and dissemination of information relating to civil aeronautics, including the periodical known as Domestic Air News, which will henceforth be published under the title of Air Commerce Bulletin.
5. The preparation and publication of airway bulletins.
6. The compilation and publication of statistics covering accidents to aircraft and other statistics on the manufacture and operation of civil aircraft.
7. The general promotion work of the Department of Commerce encouraging the development of civil aeronautics in the United States.

During the past fiscal year this division has been completely re-organized. Its activities are now distributed among four sections, all of which are under the direct supervision of the division chief: Field service section, Airway Bulletin section, statistics and distribution section, and editorial section.

FIELD SERVICE SECTION

The field service section, which was created February 4, 1929, has taken over certain phases of the work previously handled by the airport section. Among these phases are included conferences with municipalities, chambers of commerce, and similar organizations desiring assistance in the selection of airport sites and information regarding the requirements for the development of suitable airports.

Five airport specialists, including the chief of section, are available for this work. These men are routed throughout the United States on carefully planned itineraries, the usual procedure calling for the inspection of a number of sites, perhaps a talk before a civic organization at noon or in the evening, and a conference or series of conferences with officials interested in the development of the airport. The field representative then submits his report to Washington for review, after which a copy is sent to the interested community or organization.

In addition to this advisory work, the Department of Commerce is now charged with determining what improvements should be provided by applicants for the lease of public lands for airport purposes.

Another function of this section is that of rating airports upon application of the owner. This work is rapidly assuming increasing importance and application forms have already been requested by a number of cities. As yet, however, the applications are coming in slowly, due no doubt to the fact that airport officials are discovering that additional conditioning or construction work must be done before the rating they desire can be obtained.

During the year just ended a great deal of time has been devoted to a study of the management aspects of airports and to a uniform system of field rules which will apply in whole or in part to airports all over the country.

Numerous conferences have also been held in Washington with private individuals, representatives of cities and civic organizations, who are interested in developing airports. Because of limited personnel, it is frequently impossible to send a representative at the time desired by the airport or municipal officials; as the result many of these individuals have traveled long distances for conferences with this section.

From July 1, 1928, to June 30, 1929, 648 cities requested visits by one or more of this section's representatives. During the same period 636 cities were actually visited and 251 addresses delivered in the cities which were interested in obtaining an adequate airport.

AIRWAY BULLETIN SECTION

Another section of steadily increasing importance is the airway bulletin section of this division. During the past year 260 airway bulletins were issued, 29 revised, and 289 reprinted. These airway bulletins, which are distributed to a mailing list of 3,400 individuals and organizations, are illustrated loose-leaf sheets describing airports, Department of Commerce intermediate fields, airways of the country, air markings, meteorological conditions, and other data essential to air navigation.

A total of 663 airway bulletins have now been published and there are 401 additional airports to be made the subject of future bulletins. Airports are being established at the rate of 75 a month and bulletins are being completed at the rate of 40 a month. To keep the information contained in these bulletins up to date, a semiannual canvass is made. In addition to the full data which this section must get and record on all airports and intermediate fields, it keeps a record of some 6,000 other fields that may be used for landing. These fields are not scheduled for inclusion in the airway bulletins, owing to the fact that they are not set aside for the sole purpose of aircraft operations. A semiannual canvass is also made of these fields, the information being held on file for the benefit of pilots making cross-country flights who wish to know of all available landing places.

Each of the airway bulletins prepared by this section contains two maps, one of the airport itself showing wind rose and immediately surrounding terrain and the other showing the airport's location with respect to near-by railroads, rivers, and the nearest city. In addition these bulletins give the name of the airport, its class, latitude and longitude, altitude above sea level, description of surface and runways, obstructions, marking and identification, lighting, accommodation, meteorological data, and other information desired by pilots or operators.

STATISTICS AND DISTRIBUTION SECTION

The functions of the statistics and distribution section include the procurement, compilation, and analysis of all statistical data for the Aeronautics Branch, including data covering aircraft production, aircraft operation, aircraft accidents, and aids to air navigation; the preparation and publication of all statistical bulletins of the Aeronautics Branch, together with the Aeronautics Trade Directory; the contacting of other Government departments associated with aeronautics and coordinating such information for issuance; the collection of material for, and the conduct of, the reference library of the Aeronautics Branch; the distribution of all publications and printed forms of the Aeronautics Branch; the handling of correspondence

that does not pertain to the technical phases of the work; the interviewing of persons desiring general information.

In the distribution of aeronautical information this section during the last year functioned as the intermediate or contact office between the Aeronautics Branch, the aeronautics industry, and the general public, either by personal interviews, correspondence, or through the distribution of publications. As the majority of the information disseminated is prepared in bulletin form, a list of these aeronautics bulletins follows:

- | | |
|---|---|
| 1. Civil Aeronautics in the United States. | 9. United States Air Transport Routes in Operation. |
| 2. Construction of Air Ports. | 10. Airway Strip Maps. |
| 3. Aeronautics Trade Directory. | 11. Airway Distance Map of the United States. |
| 4. Air Markings for Cities. | 12. Airway Operation Costs. |
| 5. Air Ports and Landing Fields. | 13. Civil Air Accidents and Casualties. |
| 6. Aeronautical Publications. | 14. Relative Lift Distribution in any Biplane. |
| 7. Air Commerce Regulations. | 15. Air Traffic Rules. |
| 7-A. Airworthiness Requirements Regulations. | 16. Air Port Rating Regulations. |
| 7-B. School Supplement, Air Commerce Regulations. | 17. Air Port Management. |
| 7-C. Entry and Clearance of Aircraft Regulations. | 18. Abstract of State Laws on Aeronautics. |
| 8. Airway Map of the United States. | 19. Aviation Training. |

The volume of correspondence in this section has rapidly increased and during the last few months of this fiscal year an average of 700 inquiries per month were replied to by letter. An additional 3,200 requests per month were answered by the forwarding of one or more bulletins or application forms, making an average monthly total of 23,500 bulletins and 13,500 application blanks for various licenses distributed free upon request. One of the most important functions of the section is the maintenance of a mailing list which at the present time contains more than 12,000 names. This list is divided into 26 sections, each section containing the names of individuals or companies desiring a particular type of information. New and revised bulletins are forwarded on this list as well as a semimonthly publication, Air Commerce Bulletin (formerly Domestic Air News).

Aeronautical intelligence files are being developed for all data collected from the industry and other sources so that considerable time will be saved in the answering of inquiries. These files will also be invaluable as permanent records for research in analyzing the trend and progress of the industry.

Valuable statistics on the census and value of aircraft, aircraft engine, and propeller manufacture were compiled by the section. There is considerable demand for the tables prepared on airway operations, miscellaneous flying, gas, and oil consumption by the different classes of operators; also the quarterly statistical statement issued on the status of aircraft, pilots, and mechanics licensed by States. This and numerous other material is furnished the editorial section for use in the Air Commerce Bulletin (formerly Domestic Air News). Frequent requests are also received for similar data to be used in connection with articles or talks on civil aeronautics. If added personnel can be secured during the coming year, it is planned to compile statistics on additional subjects which

will be of vital interest to all concerned in the status and progress of civil aviation.

Considerable benefit has been derived from the numerous personal interviews held each day with representatives or associates of the industry in furnishing or securing pertinent data. In this way the department is able to learn how it can best serve the public in the dissemination of aeronautical information. Contact is being maintained with a number of universities offering graduate courses in finance or business administration in the exchange of data relative to the economic aspects of aviation.

Excellent progress has been made by the aeronautics reference library of this section in securing every available publication on civil aeronautics. A total of 399 bound volumes has been catalogued in addition to the more than 10,000 domestic and foreign magazines, pamphlets, and reports that are on file in the library. Complete sets of all Government aeronautical publications and a file of news clippings on aeronautical current events are kept for general reference. A semimonthly bulletin is published by this section listing references of important articles indexed by the librarian from current publications received. Close cooperation is also maintained with the engineering section in the collection of data on the latest engineering developments.

One of the most important subjects handled by this section is that of classifying and arranging civil aircraft accidents and casualties for statistical purposes. This work not only requires the continuous attention of one employee properly to classify and analyze each accident report and for the recording of the same, but requires thorough knowledge of the method of analysis set up by the special committee on the nomenclature, subdivision, and classification of aircraft accidents, of the National Advisory Committee for Aeronautics. Each accident requires individual study properly to arrive at the correct classification and analysis for statistical use. This is very important as the statistics are required for comparison and other purposes by finance and insurance companies, actuary societies, and the press service.

During the fiscal year this section has also been charged with the actual work of distributing the airway strip maps which have been sold by the department. These maps include those prepared by the airway mapping section of the Coast and Geodetic Survey, the Army Air Corps, and the Hydrographic Office of the Navy Department.

Arrangements are now being made, however, so that these maps can be sold by the principal airports, by the National Aeronautic Association, and by the American Automobile Association. The Coast and Geodetic Survey will handle the actual distribution of maps to these agencies and also sales made direct from the department. The following maps are now available at the prices indicated:

DEPARTMENT OF COMMERCE AIRWAY STRIP MAPS

[Published maps available from the Coast and Geodetic Survey, Department of Commerce at 35 cents each]

Maps published

- | | |
|-----------------------------|---------------------------------------|
| 102. Dallas-Oklahoma City. | 105. Kansas City-Moline. |
| 103. Oklahoma City-Wichita. | 110. St. Louis-Chicago. |
| 104. Wichita-Kansas City. | 111. Chicago-Milwaukee. |
| | 115. Louisville-Cincinnati-Cleveland. |
| | 119. Buffalo-Albany. |

127. Birmingham-Atlanta.
128. Atlanta-Greensboro.
129. Greensboro-Richmond.
130. Richmond-Washington.
131. Pueblo-Cheyenne.
132. Los Angeles-Las Vegas.
133. Las Vegas-Milford.
134. Milford-Salt Lake City.

Maps in process

101. Galveston-Houston-Dallas.
106. Pilottown-New Orleans.
107. New Orleans-Jackson.
108. Jackson-Memphis.
109. Memphis-St. Louis.
112. Milwaukee-Twin Cities.
113. Twin Cities-Fargo.
114. Cincinnati-Indianapolis-Chicago.
116. Cleveland-Buffalo.
117. Detroit-Grand Rapids-Milwaukee.
118. Detroit-Buffalo.
120. Albany-Boston.

121. New York-Albany.
122. Albany-Montreal.
123. Miami-West Palm Beach-Titusville.
124. Tampa-Titusville.
125. Titusville-Jacksonville.
126. Jacksonville-Atlanta.
135. Salt Lake City-Boise.
136. Boise-Pasco.
137. Pasco-Portland.
138. Salt Lake City-Pocatello.
139. Pocatello-Butte.
140. Butte-Great Falls.
141. Laredo-San Antonio.
142. Fargo-Winnipeg.
143. Atlanta-Nashville.
144. Nashville-Evansville.
145. Evansville-Chicago.
146. Evansville-St. Louis.
147. South Bend-Kalamazoo-Bay City.
148. Laredo-Houston.
149. Tulsa-Ponca City.
150. Kansas City-Omaha.

ARMY AIR CORPS AIRWAY STRIP MAPS

[Available from Coast and Geodetic Survey, Department of Commerce, at 35 cents each]

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|----------------------------------|---|
| 1. Uniontown-Dayton. | 28. San Antonio-Dryden. |
| 2. Washington-Uniontown. | 29. Dryden-El Paso. |
| 3. Washington-New York. | 30. El Paso-Tucson. |
| 4. Washington-Norfolk. | 31. Tucson-Phoenix. |
| 5. Dayton-Rantoul. | 32. Phoenix-San Diego. |
| 6. New York-Boston. | 33. Salt Lake City-Elko. |
| 7. Beaumont-New Orleans. | 34. Elko-Reno. |
| 8. New Orleans-Montgomery. | 35. Reno-San Francisco. |
| 9. Chicago-Iowa City. | 36. Dayton-Louisville. |
| 10. Iowa City-Omaha. | 37. Louisville-St. Louis. |
| 11. Omaha-North Platte. | 38. San Diego-Tucson. |
| 12. North Platte-Cheyenne. | 39. San Diego-Los Angeles. |
| 13. Cheyenne-Rock Springs. | 40. Los Angeles-San Francisco. |
| 14. Rock Springs-Salt Lake City. | 41. San Francisco-Yreka. |
| 15. Montgomery-Augusta. | 42. Yreka-Vancouver. |
| 16. Augusta-Fayetteville. | 43. Vancouver-Seattle. |
| 17. ----- | 44. Detroit-Rantoul. |
| 18. Fayetteville-Norfolk. | 45. Detroit-Cleveland-Pittsburgh-Uniontown. |
| 19. New York-Bellefonte. | 46. Washington-Middletown. |
| 20. Bellefonte-Cleveland. | 47. Detroit-Dayton. |
| 21. Cleveland-Chicago. | 48. Louisville-Nashville. |
| 22. Chicago-Rantoul-St. Louis. | 49. Nashville-Birmingham. |
| 23. St. Louis-Kansas City. | 50. Birmingham-Montgomery-Pensacola. |
| 24. Kansas City-Muskogee. | 51. St. Louis-Muskogee. |
| 25. Muskogee-Dallas. | 52. St. Louis-Dayton. |
| 26. Dallas-San Antonio. | |
| 27. San Antonio-Beaumont. | |

HYDROGRAPHIC OFFICE AIRWAY MAPS

[Published maps available from Coast and Geodetic Survey, Department of Commerce at 40 cents each]

Maps published

- | | |
|-------------------------------------|-----------------------------------|
| V-231. Boston-New York. | V-236. Morehead City-Charleston. |
| V-232. New York-Philadelphia. | V-237. Charleston-Jacksonville. |
| V-233. Philadelphia-Hampton Roads. | V-238. Fernandina-Miami. |
| V-234. Washington-Hampton Roads. | V-239. Miami-Isle De Pinos, Cuba. |
| V-235. Hampton Roads-Morehead City. | V-240. Key West-Cedar Keys. |
| | V-241. Cedar Keys-Pensacola. |
| | V-242. Pensacola-New Orleans. |
| | V-249. Habana-Port Morelos. |

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| V-250. Port Morelos—Puerto Barrios. | V-247. Puerto Mexico—Campeche. |
| V-251. Puerto Barrios—Cape Gracias a Dios. | V-248. Campeche—Cape Catoche. |
| V-252. Cape Gracias a Dios—Port Limon. | V-254. Gulf of Darien—Santa Marta. |
| V-253. Port Limon—Panama Canal Zone. | V-255. Santa Marta—Curacao Island. |
| V-264. Media Luna Cay—Cape Haitien. | V-256. Maracaibo—Caracas. |
| V-266. Batabano—Media Luna Cay. | V-257. Caracas—Port of Spain. |
| V-416. San Diego—San Luis Obispo Bay. | V-258. Port of Spain—Santa Lucia. |
| V-416A. San Diego Area. | V-259. Barbados—Barbuda. |
| V-417. San Luis Obispo Bay—San Francisco. | V-260. Barbuda—Porto Rico. |
| V-418. San Francisco—Humboldt Bay. | V-261. Porto Rico—Port au Prince. |
| V-419. Humboldt Bay—Coos Bay. | V-262. North Coast of Haiti. |
| V-420. Coos Bay—Astoria. | V-263. Port au Prince—Jamaica. |
| V-422. Astoria—Vancouver Island. | V-265. Cape Maisa—Neuvinas. |
| V-423. Seattle—Alert Bay. | V-267. Habana—Neuvinas. |
| V-424. Alert Bay—Ketchikan. | V-401. Panama Canal Zone—Cape Mala. |
| V-425. Ketchikan—Juneau. | V-402. Cape Mala—Puntarenas. |
| | V-403. Puntarenas—La Union. |
| | V-404. La Union—San Jose. |
| | V-405. San Jose—Salina Cruz. |
| | V-406. Salina Cruz—Acapulco. |
| | V-407. Acapulco—Manzanillo. |
| | V-408. Manzanillo—Mazatlan. |
| | V-409. } Gulf of California. |
| | V-412. } |
| | V-413. Mazatlan—Cape San Lucas. |
| | V-414. Magdalena Bays—Rosarita. |
| | V-415. Rosarita—San Diego. |
| | V-421. Columbia River. |
- Maps in process*
- V-230. Eastport, Me.—Boston.
 V-243. New Orleans—Galveston.
 V-244. Galveston—Corpus Christi.
 V-245. Corpus Christi—Tampico.
 V-246. Tampico—Puerto Mexico.

EDITORIAL SECTION

The editorial section issues a semimonthly bulletin entitled "Air Commerce Bulletin," which is sent to 12,000 readers who have specifically requested it. It is also circulated through aeronautical clubs, libraries, airports, and other seats of flying activities. This bulletin carries official notices to pilots, operators, and manufacturers of aircraft; air-traffic rules; notices of suspension and revocation of licenses and registrations, lists of reserve air spaces set aside by the President; statistics on operation, miles flown, accidents and their causes, gross income and operating expenses of airlines; lists of aeronautical lights certified; general notes on the progress of civil aeronautics at home and abroad; lists of air routes in operation; notes on progress of airway lighting, radio, and other aids to air navigation; lists of Department of Commerce medical examiners; articles and tabulations on airport and airway development; State laws and municipal ordinances; sample contracts; proposed airports; lists of official publications available; and other constructive information of an authentic and authoritative nature relating to civil and commercial aeronautics.

AERONAUTICAL RESEARCH DIVISION (BUREAU OF STANDARDS)

To carry out further provisions of the air commerce act, there has been established in the Bureau of Standards a division of aeronautical research having for its object the development and improvement of aids to air navigation and the promotion of safety and comfort in flight. Work accomplished by this division in cooperation with other units of the Department of Commerce during the year just ended includes: (1) Research on radio aids, (2) investigations on

airway and airport lighting, (3) wind tunnel research, (4) methods for reducing airplane noise, (5) investigation of the strength of airplane joints and fittings, and (6) type testing of aircraft engines.

RADIO AIDS TO NAVIGATION

On a clear night a pilot can follow his course along an airway readily with the aid of light beacons. During foggy weather, however, these lights can be seen for only short distances and under such conditions flight over the airways is necessarily curtailed. The solution of this difficulty has been found in the development of the radiobeacon by means of which the aviator can follow a fixed course. This requires radio stations operated by the department at a number of airports which transmit directional signals and radiophone bulletins of information. All airplanes can secure this service by the use of a simple receiving set.

These radiobeacons send out a directive type of radiation. Two sets of distinctive code signals are heard and when the signals are of equal intensity the pilot is flying on a course directly toward (or away from) the radiobeacon. With the beacons in use at present these signals have been found to be effective for navigation purposes for distances up to approximately 175 miles.

A visual course indicator has been developed by the Bureau of Standards so that it is no longer necessary for the pilot to listen continuously to the radiobeacon signals. The indicator, which is carried on the instrument board, contains two vibrating reeds, placed side by side, the ends of which are visible to the pilot. When the airplane is on its course these two reeds vibrate with equal amplitude and trace out what appears to be two white lines of equal length. If the pilot moves off his course to the right, the right line becomes longer. If he goes too far to the left, the left line becomes longer. Thus by glancing occasionally at the instrument board the pilot is enabled to fly on a direct course from one radiobeacon to another even though the ground below may be entirely obscured.

Where several airways have a common airport, such as Chicago, a multicourse radiobeacon is necessary in order to send the directive signals along the several airways. A satisfactory solution of this problem appears to have been reached by means of which the same radiobeacon is made to send distinctive signals in the proper direction along the several airways.

During the year just passed the activities of the department's aeronautical radio research group included:

(a) *Improvements of the visual directive radiobeacon system.*—Design improvements permitted the elimination of approximately 50 per cent of the beacon transmitting equipment. Specifications for the simplified transmitting equipment were prepared and a complete beacon set constructed to these specifications. A station course shift indicating instrument for use at the beacon station to check the operation of the beacon was also developed. The design of a low-power marker beacon suitable for marking the intersections of main beacon courses and dangerous places along the airways was also completed.

Experiments were begun toward increasing the number of courses served by the double-modulation directive radiobeacon in its application to airways. At many air ports, however, the number of radiating airways exceeds the possibilities of the type of beacon; the development of a beacon capable of serving 12 courses was begun and successful preliminary results obtained.

(b) *Improvements in the design of the vibrating reed course indicator.*—Changes in the design were made to permit the use of the improved modulation system at the beacon, to increase the sensitivity of the instrument, and to insure efficient operation under all conditions of weather. Specifications for the construction and adjustment of the instrument were prepared and furnished to three commercial concerns. The design of a 3-reed indicator for the multicourse beacon was begun.

(c) Cooperation with receiving set manufacturers in the design and testing of suitable beacon and telephone receiving sets.

(d) *The study of the mechanical and electrical problems involved in the design of a satisfactory ignition shielding system for airplane engines.*—Cooperation was established with airplane engine, magneto, spark plug, and cable manufacturers in order to make satisfactory ignition shielding available commercially. This shielding is deemed necessary to reduce interference with radio reception.

(e) *The study of direction finding on aircraft.*—Preliminary experiments were begun toward the development of a visual automatic direction finder of a simple type.

(f) The study of the application of the directive radiobeacon system to landing in fog.

(g) The equipping of a cabin airplane to serve as a flying laboratory for developing and testing the various radio aids to air navigation.

AIRWAYS AND AIRPORT LIGHTING

Tests on airway reflectors by a visibility method are now in progress. A standard airway reflector and a short focus reflector are mounted on a turntable. Preliminary observations from a station about 1.5 miles distant were found to be inconclusive and the apparatus has been remounted so that it can be observed from several directions, and observation points at distances of about 3, $6\frac{3}{4}$, and $8\frac{1}{4}$ miles have been selected. Observations are now in progress and it is expected that results will show whether a narrow intense beam or a broader less intense beam shows any appreciable advantage as to the visibility at the distances named.

ILLUMINATING WIND INDICATORS

A series of laboratory tests on various methods of illuminating wind cones has been made and an improved reflector system developed. This reflector system is now being given a field test at the United States Naval Air Station, Anacostia, D. C., with a 32-volt, 50-candlepower lamp installed in the reflector. For purposes of comparison, a standard airway wind cone with its regular reflector and lamp is installed on the same pole. Laboratory results with the 200-

watt lamp indicate that the average brightness of the cones can be increased six or seven times.

Samples of various cloths have been tested and experiments have been made on several methods of treated cloths in order to increase the transmission of light through them. New cones are being made up from the most promising and untreated fabric and laboratory measurements are in progress on these fabrics.

NEON VISIBILITY TEST

A visibility test on the light from a neon lamp as compared with the light from an incandescent filament lamp with red color filter was conducted at Moody Point, Me. The apparatus for the test was erected at a place on the coast where a range of observation of about 4.5 miles was available, the particular location having been selected on the basis of fog records of the Bureau of Lighthouses for some years. The apparatus was in no sense an aviation beacon, but was designed solely for observation by observers patrolling the shore.

The rotating experimental beacon was so operated that three flashes of light could be seen successively—a neon flash, a red flash from an incandescent lamp with color screen to match the neon color, and a clear flash from an incandescent lamp without color screen.

For the neon lamp and the incandescent lamp, with red color filter, the 15 millimeter aperture in each unit had the same candlepower, the same color, and the same horizontal light distribution as closely as was experimentally possible. When the red color filter was removed from its unit the two incandescent beams were also of approximately the same candlepower, color, and horizontal distribution. Three different neon lamps of the hot cathode type were used. The complete equipment, with motor, rheostats, and electrical measuring instruments, was erected.

Thirty-three sets of observations were made—in clear weather, in haze, in fog, and in rain. One fog observation was made in daytime. The method of observation varied somewhat, depending on the weather, but generally observations were made from five stations, approximately 4.5, 3.5, 3, 2.5, and 1.25 miles from the beacon.

Observations were made with the naked eye and with a photometric wedge. No differences sufficiently great to be detected by the methods used in this test were found between the visibility of light from a neon lamp and light of the same color, candlepower, and horizontal distribution produced by an incandescent filament lamp with color screen.

INVESTIGATION OF STABILITY OF AIRPLANES AT LOW SPEEDS AND HIGH STALLING ANGLES

The work on this subject has so far been confined to wind-tunnel investigations of the effect of changes in the chord and span of ailerons on the rolling and yawing moments of aircraft. The investigation was first made at low angles of attack. A second investigation dealing with high angles of attack is now being made.

This work has excited the interest and favorable comments of airplane designers. It has a direct bearing on the control of airplanes

at low speeds and high angles of attack. The blanketing effect of the wing on the aileron at high angles of attack is clearly brought out in these measurements, which provide a basis for more effective aileron design.

This is a direct service to manufacturers, aiding as it does in determining the performance of a new type of airplane previous to actual construction, and at the same time advances the department's policy of increasing safety in the air by affording information on the probable behavior of new types of aircraft.

REDUCING AIRPLANE NOISE

Comfort as well as safety must be considered in the transportation of passengers by air, and a study is being made of the various means of reducing the noise in the cabins of passenger airplanes. This will include eventually the study of various types of muffling devices for the engine exhaust and of methods of reducing propeller noise, but the first work has been directed toward the partial sound proofing of airplane cabins. The weight of the material used is, of course, an important factor. It has been found that a cabin wall built up of layers of suitable materials is far more effective from a sound-proofing standpoint than a single layer of material of the same weight.

A composite cabin wall, consisting of five layers of material, has been developed as a result of the bureau's laboratory work. An experimental installation was made in a 3-motored ship and it was found possible to carry on a conversation in an ordinary tone of voice without difficulty when the windows were closed. The weight of this material is a little over 1 pound per square foot of interior cabin wall and the manufacturers would like to see this reduced, if possible.

Since each type of airplane presents its special problem in insulating the cabin against sound, to get the best results it is consequently desirable to work directly with the manufacturers. It is highly important to make the interior of the cabin sound absorbing. Without sound absorption in the interior the noise will eventually build up to the full intensity of the outside noise no matter how effective the insulation may be. At the same time the interior of the cabin must be as nearly fireproof as possible. This requirement, together with that of minimum weight, adds to the difficulty of finding an effective solution.

WELDED JOINTS

The general use of steel tubing welded at the joints, in airplane construction, has created a demand for more complete and reliable data on the strength and other properties of welded joints in structural members. This investigation was undertaken to assist the aeronautics branch of the Department of Commerce in its main function of promoting safety in aviation.

The strength of all types of joints in common use and the relative work of each is being determined and new types will be developed which may be better than any now in use.

Testing has been completed on the first group of joints, 165 in all. These joints were designed from data supplied by manufacturers, welded under procedure control, and tested in special fixtures.

The results of this first series are being prepared as a progress report for publication as a technical note of the National Advisory Committee for Aeronautics.

From data based on the results of these tests more improved joints will be made and finally the best type for each purpose will be determined.

Eighty-five joints, including all the T-joints, have been tested so far. Tension and compression specimens from every tube used, have been tested. Although no quantitative data are available for this report, several conclusions based on observation may be made.

The most serious problem encountered in designing reinforcement in a welded joint is the formation of cracks in gusset plates after cooling. It is evident that the problem is one of design as well as of welding technique. Best results seem to be obtained by making the thickness of gusset plates somewhat greater than the tube thickness and keeping the plan area of the gusset as small as possible. Whenever possible the design should allow for movement of the members as the joint cools.

The relative cost and weight of each joint as well as the strength will be determined.

As soon as testing has been completed a new series of joints will be made based on the data obtained from these tests.

TESTING OF AIRCRAFT ENGINES

The air commerce regulations of the department provide that all airplanes engaged in interstate air commerce must contain power plants of a type approved by the department. The engines first used in commercial planes were those designed and built for military purposes, and these engines are known to be safe because they have been thoroughly tested by the Army or the Navy. The great popularity of the air-cooled engine has led to the design of new engines by many manufacturers, and such engines must pass type tests by the Army, the Navy, or the Department of Commerce before they can be certified as airworthy by the Director of Aeronautics.

The present test requirements include (1) a 50-hour endurance test to be run in ten 5-hour periods, (2) full-throttle runs to determine the power developed at speeds ranging from 75 to 110 per cent of the rated speed, and (3) a flight test of the engine installed in an airplane. New equipment for engine testing has just been installed by the Bureau of Standards at Arlington, Va., including three open torque stands on which engines are run with propeller load, the torque reaction being measured on the engine mounting. With this new equipment, combined with that already available, it is expected that tests can be carried out at the rate of one engine per week, which is approximately the rate at which requests are now being received. Less than 50 per cent of the engines so far tested have successfully met the department's requirements on the first trial, which shows the necessity of conducting type tests before authorizing the use of new types of engines in interstate commerce.

The Government makes no charge for these tests, but the manufacturer is required to provide his own fuel and oil. Each power plant is considered on its own merits and there are no standard requirements as to weight per horsepower or fuel or oil consumption per horsepower-hour. Sound design, adequate materials, good workmanship, and reliable performance of the engine and its accessories are required.

The testing of commercial engine types to determine their suitability for use in licensed aircraft has been carried on actively throughout the past fiscal year. Tests were made on 26 engines, of which number 12 failed, 5 were withdrawn, 2 are still under test, and 7 have been approved. Of the 12 unsuccessful engines, only 1 completed half of the endurance test and 6 failed in the first period. Ten failures occurred in the first six months and most of them revealed faults which could readily be corrected by the engine manufacturer. Three engines have already passed the test after an initial failure and the voluntary withdrawal of other engines for further development work promises to save time and expense to the manufacturer as well as to the Government.

The basis on which commercial aircraft engines are rated was modified slightly in November, 1928. Instead of requiring the engine manufacturer to specify both rated speed and rated power, he is asked to designate only the maximum speed at which the engine should be operated at full throttle. This is taken as the rated speed and the rated power is determined by the average brake horsepower developed in the first 5-hour period of the endurance test which is run at full throttle and rated speed. The remaining nine 5-hour periods of the endurance test are run with the engine throttled sufficiently to reduce power not more than 10 per cent.

Shortly after the work was started it was found that applications for type tests were coming in at the rate of one a week while tests at College Park required from one to three weeks each. It also developed that the air blast available in connection with the dynamometer test stand at the Bureau of Standards was insufficient for endurance test work with most air-cooled engines so this equipment has been useful chiefly for testing water-cooled engines and for calibrating the smaller air-cooled engines. Plans are being made to provide facilities for cooling air-cooled engines of larger power. Engine testing equipment, including three complete torque stand units, has been installed at Arlington, Va., during the past six months and two of the units are now in operation.

The use of special 4-blade wooden test propellers has afforded a satisfactory solution of the cooling problem on the torque stand, but the magnitude of the windage correction is found to vary within wide limits for different designs of engine. This correction is determined experimentally for each engine by dynamometer calibration or other suitable means.

To avoid interruptions in the test schedule due to postponed test dates, applications for test are now required to be accompanied by complete engine specifications and drawings and by an affidavit that the engine has satisfactorily completed the required 25-hour preliminary bench test. Seven engines which have met these preliminary requirements are now awaiting test.

Members of the Bureau of Standards staff have assisted individual engine manufacturers in solving technical problems in connection with engine design and engine testing and have presented the objects and lessons of commercial aircraft engine type testing at an A. S. M. E. aeronautical meeting in Wichita, at the first national aeronautical safety conference in New York, and at the international civil aeronautics conference in Washington. The problems involved in type testing and the coordination of civil and military type testing have been considered by the N. A. C. A. committee on power plants for aircraft on several occasions.

A field representative of the Bureau of Standards has been recently designated as liaison officer between the Aeronautics Branch and those engaged in the development, testing, production, and inspection of commercial as well as military aircraft engines. Through his activities the Bureau of Standards will be informed as to current methods and equipment for engine testing as used by the military establishments and by individual engine manufacturers while the Aeronautics Branch will be informed as to the relative quality of the inspection applied to commercial and military engines. He will also be able to cooperate with and assist the engine manufacturers whose plants he visits.

AIRWAY MAPPING SECTION (COAST AND GEODETIC SURVEY)

Another highly important function of the Aeronautics Branch is the preparation of airways maps and charts for air navigation. This is carried on by the Coast and Geodetic Survey, a bureau of the Department of Commerce.

The maps now being compiled, which are usually referred to as "strip maps," are published on a scale of 1 to 500,000, or about 8 miles to the inch. Each map covers a strip 80 miles in width and from 200 to 400 miles in length; and the size of each sheet is 11 inches in width and 24 to 48 inches in length, making a convenient form and size to be folded for use by the pilot.

The material used in the compilation of these airways maps is taken from various sources. Among the best of these are the topographic maps of the United States Geological Survey; and the contour lines forming the boundaries for gradients of elevations on airways maps are almost always taken from these topographic maps.

After an air-map compilation has been made from the best available material, photographic copies mounted on cloth are taken to the field and checked. This work is done by a trained engineer, who goes as an observer with an experienced pilot. A number of trips are made back and forth across the region represented until the whole area is covered. The compilation is then accordingly corrected and lithographic impressions are made on a scale one-fourth larger than the compilation. One of these sheets is inked for each color to be printed on the map. When the inking is finished the drawings are again reduced by photography to the original scale and the negatives are used to prepare the aluminum plates for printing the edition.

The maps are printed in color, the better to express such various features as streams, elevations, airports, flight courses, and magnetic variations.

The rapid development of airway routes has already brought about duplication of mapping due to the overlapping of routes between the various cities. To solve this difficulty and also to furnish charts for those who do not follow the regular routes, sectional charts will be constructed which will be called "United States Airway Charts." For these charts the United States has been divided into sections, each covering 3° of latitude and 4° of longitude, which allows the publication on an average-sized sheet 26 by 28 inches, using the same scale as the strip maps, 8 miles to the inch.

The first of these sectional United States airway charts to be published will be east of the Mississippi River, where the multiplication of routes creates an urgent need for this form of chart.

It is likely that the strip maps may be printed and used extensively along the established airways even after the sectional charts are made, but for general use the larger charts will be in greater demand. One may mark out a particular route on a sectional chart or across two joined charts and then cut out the strip and fold to a convenient size for use on the proposed trip.

Prior to the creation of the Aeronautics Branch, the Army Air Corps had prepared a number of airways maps for military use. The Coast and Geodetic Survey is not duplicating these; but the Air Corps is maintaining its supply of such maps and the Coast and Geodetic Survey is preparing new ones of the various routes not otherwise covered.

During the past year the following strip maps were published:

- | | | |
|---------------------------|--|---------------------------|
| 128. Atlanta-Greensboro. | \| | 130. Richmond-Washington. |
| 129. Greensboro-Richmond. | \| |  |

Work was continued on the following maps:

- | | | |
|--------------------------------------|--|-----------------------------|
| 112. Minneapolis-St. Paul-Milwaukee. | \| | 132. Los Angeles-Las Vegas. |
| 114. Chicago-Cincinnati. | \| | 133. Las Vegas-Milford. |
| 115. Louisville-Cleveland. | \| | 134. Milford-St. Lake City. |
| 116. Cleveland-Buffalo. | \| | 135. Salt Lake City-Boise. |
| 119. Buffalo-Albany. | \| | 136. Boise-Pasco. |
| 127. Birmingham-Atlanta. | \| |  |

Nos. 127, Birmingham-Atlanta, and 119, Buffalo-Albany, were delivered to the printing section, but due to removal of the Coast and Geodetic Survey to new quarters these were not printed.

Nos. 112, Minneapolis-St. Paul-Milwaukee; 114, Chicago-Cincinnati; 115, Louisville-Cleveland; and 116, Cleveland-Buffalo, have been compiled and are awaiting flight checks.

Nos. 132, Los Angeles-Las Vegas; 133, Las Vegas-Milford; and 134, Milford-Salt Lake City, receiving priority, the compilations were finished and the final drawings were begun.

Work was begun on the following maps:

- | | | |
|-----------------------|--|-----------------------|
| 121. New York-Albany. | \| | 122. Albany-Montreal. |
|-----------------------|--|-----------------------|

Reprints were made of the following maps:

- | | | |
|-----------------------------|--|-------------------------|
| 102. Dallas-Oklahoma City. | \| | 111. Chicago-Milwaukee. |
| 103. Oklahoma City-Wichita. | \| | 131. Pueblo-Cheyenne. |
| 110. St. Louis-Chicago. | \| |  |

Distances were scaled and furnished the air mail contract division of the Post Office Department, airports and aeronautic information division of the Aeronautics Branch, Department of Commerce, and various items of information to the public.

The original compilation of sectional or general flying charts of the entire country is a project over twice as large as the original strip-map program. This alone will require more than nine years to complete with existing facilities. In addition, about 50 strip maps or three or four years' work will be required to fill urgent demands while the general charts are being constructed. By concentrating upon the compilation of original charts the country can not be covered at the earliest before 1940. In the meantime there will undoubtedly be a vast amount of revision and corrections to be made to existing charts that may easily defer completion of the original project for an additional 10 years. The requirements of chart users in 1950 can not be forecast, but charts constructed and put to use now will by that time have served their purpose. It therefore appears imperative that the personnel of the airways mapping section, which henceforth will be known as the airways charting section, be greatly increased if chart production is not to be left behind the demand.

ADMINISTRATIVE SECTION

The administrative section, which acts in the capacity of a service unit for the various divisions and sections of the Aeronautics Branch, is charged specifically with the handling of all appropriations and accounting matters; the handling of personnel records and all work relating thereto; the maintenance of central file records; the purchasing of and accounting for all property, including special aeronautical equipment of all kinds; and all other general administrative work relating to the operation of the Aeronautics Branch.

Funds for carrying on the work of the branch are appropriated under two titles, namely, "Aircraft in commerce" and "Air navigation facilities." The appropriation "Aircraft in commerce" is used primarily for salaries and traveling expenses of inspectors engaged in the inspection and licensing of aircraft, for salaries of employees necessary to carry on the work at the Washington office, for the testing of aircraft engines, and for conducting other research work in connection with such subjects as soundproofing airplane cabins, the testing of welded joints in steel tubing, etc. The appropriation "Air navigation facilities" is used primarily for the construction and maintenance of civil airways. A small portion of this appropriation, however, is used for the payment of salaries of airport specialists who are engaged in assisting municipalities and private enterprises in the selection of airport sites and for research work in connection with the development of aids to air navigation such as radiobeacons, course light, fog landing instruments, etc. Below is a tabulation of the amounts that have been appropriated under these two heads since the Aeronautics Branch began to function:

Fiscal year	Aircraft in commerce	Air navigation facilities	Total
1927 ¹	\$250,000	\$300,000	\$550,000
1928.....	700,000	3,091,500	3,791,500
1929 ²	859,500	4,659,850	5,519,350
1930.....	958,000	5,458,620	6,416,620

¹ Second deficiency act, fiscal year 1926, approved July 3, 1926.

² Includes under "Aircraft in commerce," \$72,500 appropriated by the second deficiency act of 1928 and \$85,000 appropriated by the second deficiency act of 1929 and under "Air navigation facilities," \$1,000,000 appropriated by the second deficiency act of 1928.

Despite the fact that air-commerce operations increased considerably more than 100 per cent during the fiscal year 1929, the total personnel of the Aeronautics Branch increased only 63 per cent and the appropriations but 45 per cent. The largest personnel increase has been in the licensing section, necessitated by the constantly increasing volume of clerical work occasioned by the unprecedented growth of the aeronautical industry.

Much difficulty has been encountered securing personnel with the necessary qualifications and experience. Men properly equipped for appointment as aeronautical inspectors and aeronautical engineers, for example, are usually receiving or in a position to demand higher salaries than the department can offer, and it is only by the knowledge that working for the Aeronautics Branch they will gain experience which they can not obtain elsewhere in anything like as short a period that the department has been able to secure the type of men that it has. The standards for appointment are quite high, but, with the work that must be done, this of course is essential.

During the year the field offices opened at Atlanta, Ga., Kansas City, Mo., Dallas, Tex., Oakland, Calif., Los Angeles, Calif., Detroit, Mich., Chicago, Ill., Philadelphia, Pa., and Garden City, Long Island, N. Y., have been equipped with all necessary furniture and other office appliances and supplies. The five additional airplanes which were authorized in the 1929 appropriation act were purchased, bringing the total for regulations work up to 20. This number is quite inadequate and the lack of suitable equipment in the form of aircraft has been a decided handicap in the carrying out of many of the duties intrusted to the department under the air commerce act. It is a most difficult task effectively to advocate the use of aircraft when pilots of our own service do their traveling in railroad trains and taxicabs. Also the enforcing of the air-traffic rules without the use of aircraft is as difficult as the task of a traffic officer endeavoring to enforce the speed laws without a motor cycle or automobile. Specifications were written for, and purchase made of, other special flying equipment, such as winter flying suits, parachutes, moccasins, etc., which are required for use by the department's pilots engaged in the flight testing of aircraft, the examining of pilots, etc.

During the year the hangar at Bolling Field was celotexed and an engine overhaul room completely equipped and furnished, including the installation of an air compressor and other special repair equipment. The work of overhauling the department's own motors is now well under way, and this will undoubtedly result in a material saving while at the same time providing repair work of uniform quality. The department's mechanics stationed at Bolling Field, in addition to servicing the motors and ships employed in the Aeronautics Branch's regulation and inspection work, are now servicing the ships and motors of the airways division whenever they are in Washington.

II. DEVELOPMENT OF CIVIL AERONAUTICS

The past year has witnessed important developments in virtually every phase of civil aeronautics. Spectacular achievements have combined with day-in and day-out scheduled operations to bring aero-

navics before the public to an unprecedented degree, which in turn has enabled the industry to advance with gratifying celerity. Perhaps because of this, capital in rapidly increasing volume has been made available for aviation. The urge to merge, which has been noticeable throughout the business world during the past few years, has resulted in numerous consolidations of varying magnitude, both in the manufacture of aircraft and in the operation of air lines. Air commerce, the dream of centuries, has now become an integral part of the Nation's business.

Actual aeronautical progress during the fiscal year of 1929 includes the increases in businesses already established, the inauguration of operations previously only in project, and totally new developments. Another classification of progress, in both subdivisions of which very large strides have been made, includes (1) scheduled transport, which consists of regularly scheduled operations over

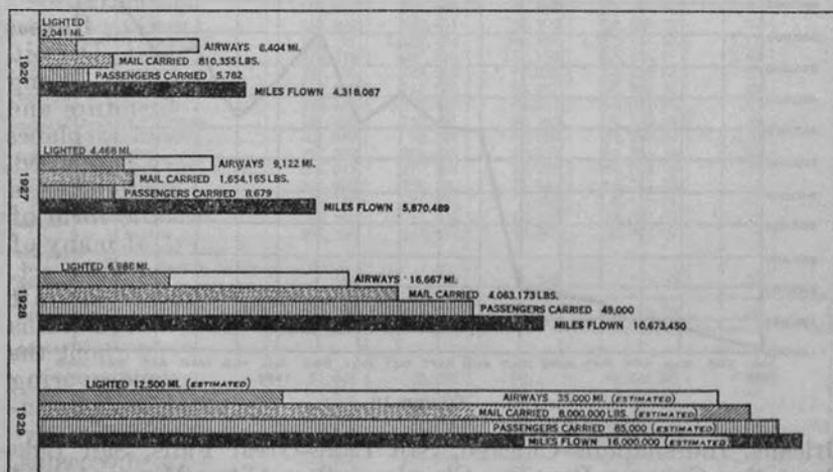


FIGURE 9.—Alrway operation progress

established routes; (2) miscellaneous air services, which include sightseeing, messenger service, aerial photography, student instruction, private flying, etc.

SCHEDULED AIR TRANSPORT

Table E shows that during the year ended December 31, 1928, 35 different companies operated over civil airways 59 different scheduled air lines and flew a total distance of 10,673,450 miles. These operators transported 49,713 passengers, 1,848,156 pounds of express, and 4,063,173 pounds of mail.

There are now 29,227 miles of established airways in the United States; and it will be noted by referring to Table C (pp. 24-26) that 10,183 miles of these airways are now lighted for night flying. Moreover, 2,065 additional miles of lighted airways are now actually under construction.

This established airway system is the backbone of the Nation's commercial aviation, although operations over this network of airways constitute only about 15 per cent of all civil flying. During the past year scheduled operations have increased from 27,817 to 69,029 miles per day.

Additional routes covered by scheduled air lines since July 1, 1928, include St. Louis-Omaha, Tulsa-Ponca City, Oakland-San Jose, Milwaukee-Green Bay, Louisville-Cleveland, Akron-Cleveland, Chicago-Cleveland, Washington-New York, Cleveland-Buffalo, Brownsville-San Antonio, San Antonio-Fort Worth, Houston-New

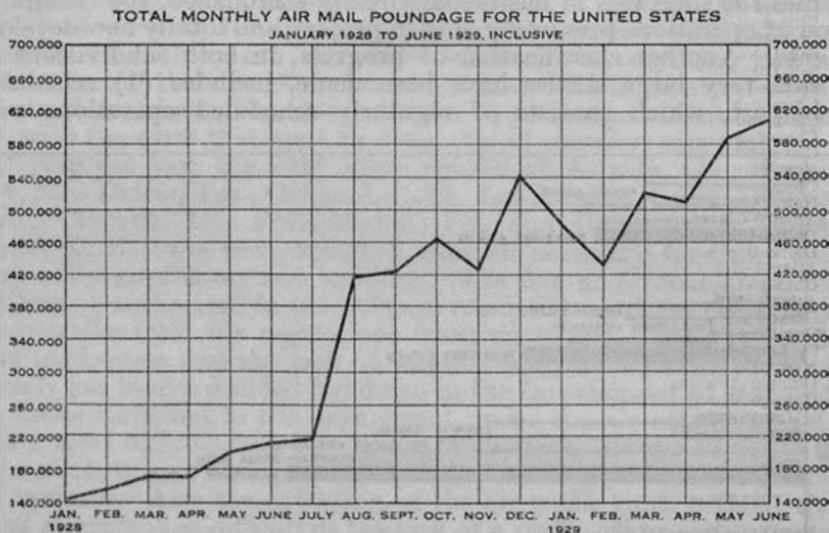


FIGURE 10

Orleans, Indianapolis-Chicago, Salt Lake-Great Falls, Salt Lake-Pocatello, Chicago-Pontiac, Cleveland-Bay City, Miami-Atlanta, Tampa-Daytona Beach, Atlanta-Chicago, St. Louis-Evansville, Los Angeles-Phoenix, Tulsa-Dallas, Louisville-Indianapolis, Indianapolis-Detroit, El Paso-Dallas, Des Moines-Waterloo, Tulsa-St. Louis, Sweetwater-Tulsa, Tulsa-Kansas City, Portland-Spokane, Kansas City-Minneapolis, Los Angeles-Kansas City, and Garden City-Cleveland.

These new routes include connections with Canada, Mexico, Central America, and South America. Foreign routes inaugurated during the year include New York-Montreal, Miami-Nassau, San Juan-Miami, Miami-Cristobal (Canal Zone), Brownsville-Mexico City, Cristobal-Mollendo (Peru), and Seattle-Vancouver.

TABLE E.—Air mail operation statistics

	January-June, 1929 (inclusive)					July-December, 1928 (inclusive), revenue per scheduled mile
	Miles of service		Total, weight of mails dispatched	Amount paid to contractor	Revenue per scheduled mile	
	Scheduled ¹	Actually flown				
DOMESTIC ROUTES						
			<i>Pounds</i>			
1. Boston-New York.....	63,936	53,971	50,926	\$152,729.87	\$2.39	\$2.06
2. Chicago-St. Louis.....	134,830	131,241	40,149	101,629.45	.75	1.34
3. Chicago-Dallas (night).....	387,325	324,079				
3. Chicago-Kansas City (day).....	168,418	147,302	169,903	511,031.09	.92	.81
4. Salt Lake City-Los Angeles.....	317,699	302,417	335,159	1,005,297.68	3.16	2.98
5. Salt Lake City-Pasco.....	197,816	175,651	98,393	294,579.04	1.49	1.38
8. Seattle-Los Angeles.....	388,523	375,419	114,852	325,027.00	.84	.76
9. Chicago-Minneapolis.....	328,157	299,536	65,610	180,378.53	.55	.87
11. Cleveland-Pittsburgh.....	61,867	57,199	51,645	154,610.56	2.50	2.83
12. Cheyenne-Pueblo.....	79,328	77,240	45,533	37,792.07	.48	.46
16. Cleveland-Louisville.....	156,818	141,565	45,408	55,346.62	.35	.31
17. New York-Chicago.....	652,309	562,651	737,304	638,058.22	.97	.91
18. Chicago-San Francisco.....	1,182,191	1,127,724	803,496	1,632,744.43	1.38	1.40
19. New York-Atlanta.....	279,512	246,216	151,136	453,405.91	1.62	1.08
20. Albany-Cleveland.....	157,553	134,302	49,323	84,739.68	.60	.45
21. Dallas-Galveston.....	118,638	113,888	24,551	70,948.96	.55	.35
22. Dallas-Brownsville.....	180,612	173,457	40,361	116,600.40	.65	.65
23. Atlanta-New Orleans.....	161,396	150,321	40,444	70,778.84	.44	.26
24. Chicago-Cincinnati.....	101,688	92,133	35,569	52,263.05	.51	.43
25. Atlanta-Miami.....	217,860	209,613	58,482	85,384.46	.39	.20
26. Great Falls-Salt Lake City.....	203,219	177,193	29,985	74,185.46	.37	.37
27. Bay City-Chicago.....	235,995	199,280	73,881	65,754.73	.28	.40
28. St. Louis-Omaha.....	49,166	45,834	8,420	6,610.44	.13	
29. New Orleans-Houston.....	92,510	87,438	18,883	18,883.62	.20	
30. Chicago-Atlanta.....	283,295	258,668	49,900	38,993.07	.14	.13
31. Chicago Municipal Airport-Grant Park Ramp, Chicago.....	135	135	3,349	210.00	1.56	
Total.....	6,200,794	5,664,373	3,142,652	6,193,083.18	1.00	1.03
FOREIGN ROUTES						
1. New York-Montreal.....	51,916	46,476	(²)	44,616.96	\$ 1.48	\$ 1.48
2. Seattle-Victoria.....	9,856	9,856	(²)	9,120.00	\$ 1.43	\$ 1.93
3. New Orleans-Pilotown.....	31,800	31,800	(²)	15,900.00	\$ 1.50	\$ 1.50
4. Miami-Habana.....	94,482	99,180	(²)	99,180.00	\$ 1.00	\$ 1.00
5. Miami-Canal Zone.....	178,364	178,364	(²)	356,728.00	\$ 2.00	
6. Miami-San Juan.....	213,860	213,599	(²)	425,688.00	\$ 2.00	
7. Miami-Nassau, Bahamas.....	30,800	30,400	(²)	30,400.00	\$ 1.00	
8. Brownsville-Mexico City.....	106,652	105,728	(²)	105,728.00	\$ 1.00	
Total.....	717,730	715,403	325,910	1,087,360.96	\$ 1.52	\$ 1.76
Grand total.....	6,918,524	6,379,776	3,468,562	7,280,441.14	1.05	1.02

¹Miles scheduled as estimated by Post Office Department on basis miles of route times trips scheduled. Actual miles flown on regular schedule plus ferry and test mileage amounts to practically the same as scheduled mileage.

²Poundage on individual routes not available.

³Revenue per mile actually flown used instead of scheduled miles.

The growing aggregate of air passenger traffic, the mounting total of air express tonnage, the increasing volume of air mail poundage all prove that the airplane has won a definite place in the general transportation scheme. The establishment of the new air mail rate of 5 cents for the first ounce and 10 cents for each additional ounce, has resulted in a highly gratifying volume growth—domestic air mail alone having increased during the past fiscal year from 210,957 to 598,494 pounds per month.

The trade areas directly served by air routes now contain approximately 90,000,000 people, and nearly 100 cities having station stops on these airways. By the close of the next fiscal year it is believed that practically all of the larger centers of population and many of the medium-sized cities will be directly connected by roads of the sky; and that many other outlying cities, whose locations do not warrant their being placed as stopping points on regular lines, will be served by smaller "feeder" air lines.

Already there are 32 United States air lines carrying express, 47 air lines carrying mail, and 61 air lines carrying passengers. Of these, 23 carry passengers only, 16 carry mail only, and 2 carry express only. Of the remainder, 12 carry passengers and express, 13 carry mail and passengers, 5 carry express and mail, and 13 carry mail, express, and passengers.

The equipment and navigational facilities on most of these lines are rapidly improving, and cabin planes are becoming standard equipment on many routes to protect passengers from wind and weather. Although notable strides have been made during the past 12 months, even greater advances are anticipated during the coming year.

MISCELLANEOUS AIR SERVICES

Because scheduled air transport is the backbone of America's commercial aeronautics, business men usually focus upon it the greater part of their attention. Notwithstanding this, however, scheduled operations comprise less than one-sixth of the civil flying in the United States, the remainder consisting of nonscheduled commercial services and private flying. These miscellaneous air services include sightseeing, student instruction, crop dusting, aerial photography, mapping, messenger service, advertising, charter or taxicab service, and several other classes of operations.

So rapidly has this class of flying increased that it is impossible to obtain authentic figures to indicate its progress. It is estimated, however, that during 1926 more than 18,000,000 miles were flown by miscellaneous operators; that in 1927 the mileage flown increased to 30,000,000 miles, and that in 1928 the total increased to 60,000,000 miles.

The instruction of students in particular has increased at an unprecedented rate during the last 12 months. To take care of this augmented demand, the number of flying schools, which 12 months ago totaled 320, has now increased to nearly 600; and the constantly mounting number of applications for student pilots' permits indicate that during the next fiscal year the reputable flying schools will probably be taxed to the limit.

An important result of miscellaneous air service, which in turn is resulting in the further development of nonscheduled flying, has been the steady increase in the number of airports in the United States. It has long been recognized that established schedule routes require proper terminals and ground facilities; but many cities refused at first to establish their own airports unless regular routes were promised them. Miscellaneous services, however, have now grown to such proportions that they far exceed in volume the scheduled operations, with the result that many cities throughout the Nation have been forced to acquire and construct adequate airports to take care of this traffic.

Until recently these miscellaneous operations were frequently considered doubtful by cities contemplating municipal airports; with the advent of the Department of Commerce's licensing system, however, by which prospective users of nonscheduled services can determine the airworthiness of planes and competency of pilots, this doubt is being dissipated steadily. With the passage of uniform State legislation covering intrastate air commerce, unscrupulous pilots and operators flying aircraft of questionable airworthiness are being rapidly eliminated. As a result, public confidence is being established completely in this type of operations as well as in scheduled air transport.

Private flying, too, is developing very rapidly and the widespread growth of flying clubs is further increasing these operations. By private flying is meant the operation of aircraft for sport and pleasure and for private use of business men. The latter phase includes aircraft utilization by salesmen when traveling from one territory to another, the operation of planes to carry business executives on inspection visits to various factories and branches and the use of planes by doctors, engineers, lecturers, and numerous others who have occasion to travel more or less regularly over medium distances.

The not unreasonable price of modern airplanes and the fairly low costs of their operation, together with the establishment of navigational facilities and other aids being provided by the Government and the industry itself, are now making it comparatively easy for the private owner to use his plane with a high degree of safety, comfort, profit, and satisfaction.

AIR-RAIL SERVICE

Perhaps the most important development during the past year has been the establishment of combined airplane and railroad passenger service. Although this has been projected for several years, only a few lines had actually started operations prior to July 1, 1928. To-day, however, there are five transcontinental air-rail lines in daily operation from coast to coast. Whereas before this hook up of air lines and railroads the minimum time required to complete a journey from New York to Los Angeles by rail was 102 hours, the same trip can now be made in 44 hours. Railroads already collaborating with established air lines include the Pennsylvania, New York Central, Chicago & Alton, Atchison, Topeka & Santa Fe, and others. Furthermore, many other major railroads and important steamship lines are contemplating similar hook ups, which will undoubtedly become effective within the next 12 months.

TABLE F.—Scheduled airways operations statistics, July–December, 1928

		Operators reporting
Engine-hours	67, 117	27
Miles flown	5, 657, 661	27
Passengers carried	18, 971	26
Express carried (pounds)	802, 785	
Pilots on detail	275	28
Mechanics on detail	499	26
Other operating personnel	262	19
Total personnel	1, 036	28
Pilots' pay:		
Base	\$194. 02	25
Rate per mile, day	\$0. 055	25
Rate per mile, night	\$0. 093	25
Base and other total	\$463. 513	25
Mechanics' and riggers' pay:		
Pay monthly	\$164. 375	27
Hour	\$0. 761	18
Trips possible	11, 977	27
Trips attempted	11, 664	27
Trips completed	10, 796	27
Trips completed, per cent	92. 6	27
Average hours flown per month per pilot	68	25
Equipment:		
Number of planes	268	29
Value	\$5, 226, 569. 70	29
Revenues:		
Passenger	\$452, 561	25
Mail	\$4, 849, 812	25
Express and freight	\$66, 677	25
Miscellaneous	\$117, 218	25

AIR MARKING

The air marking of cities, towns, and highways is one of the most important aids now required by the industry. Cross-country flying by pilots of average ability and limited experience will be greatly facilitated as soon as each Federal and State highway and the majority of cities and towns throughout the Nation are properly marked for identification from an altitude of 2,000 feet. To accelerate this consummation, a committee was organized to study the subject of highway marking and to recommend a standard system for general use throughout the United States. The committee of six representing the Aeronautics Branch of the Department of Commerce, the Bureau of Aeronautics of the Navy Department, the National Airway Marking Association, and the Army Air Corps, undertook this work on June 4, 1928. In conjunction with its studies a review was made of the suggestions and designs for air markings submitted at the airways marking conference held at Wichita, Kans. Studies were also made of a large number of suggestions received from other sources and of reports covering various tests on the visibility of different color combinations and the illumination of large advertising signs.

After these studies were made the committee made an extended series of actual flight tests in which markings of various designs, sizes, and colors were painted on large canvases placed on the roof of the Commerce Building in Washington and tested under a wide

variety of weather conditions. As the work progressed there were many eliminations and numerous changes made in those markings offering the greatest promise until highly satisfactory results were obtained under daylight conditions. From this point on night tests were made in which the markings were illuminated by different methods and through a wide range of intensities. These tests, which were concluded on January 5, 1929, brought out the need for certain changes in the markings which had not been indicated by the day tests.

TABLE G.—Air-mail contract rates

[C. A. M.—Domestic contract air mail. F. A. M.—Foreign contract air mail]

Route	Rate per—	Route	Rate per—
C. A. M.		C. A. M.	
	<i>Pound</i>		<i>Pound</i>
1. New York-Boston.....	\$3.00	27. Chicago-Muskegon-Bay City-Pontiac.....	\$0.89
2. Chicago-St. Louis.....	2.53	28. St. Louis-Omaha.....	.785
3. Dallas-Chicago.....	3.00	29. Brownsville-New Orleans.....	1.00
4. Los Angeles-Salt Lake City.....	3.00	30. Atlanta-Chicago, with St. Louis spur.....	.78
5. Salt Lake City-Pasco.....	3.00		
6. Los Angeles-Seattle:		Average rate per pound.....	2.09
Up to 1,000 miles.....	2.81		
Entire route.....	3.09	F. A. M.	
9. Chicago-Minneapolis-St. Paul.....	2.75	3. Pilottown-New Orleans.....	(¹)
11. Cleveland-Pittsburgh.....	3.00		
12. Pueblo-Cheyenne.....	.83		
16. Louisville-Cleveland.....	1.22	1. New York-Montreal.....	\$0.96
17. Chicago-New York.....	¹ 1.24	2. Seattle-Victoria.....	.76
18. Chicago-San Francisco.....	² 3.00	4. Miami-Habana, Cuba.....	2.00
19. Atlanta-New York.....	3.00	5. Miami-Cristobal, Canal Zone.....	2.00
20. Cleveland-Albany.....	1.11	6. Miami-San Juan, P. R.....	2.00
21. Galveston-Dallas.....	2.89	7. Miami-Nassau.....	2.00
22. Brownsville-Dallas.....	2.89	8. Brownsville-Mexico City.....	2.00
23. New Orleans-Atlanta.....	1.75	9. Cristobal-Santiago, Chile.....	1.80
24. Cincinnati-Chicago.....	1.47		
25. Atlanta-Miami.....	1.46		
26. Salt Lake City-Great Falls.....	2.475		

¹ Up to 1,500 pounds a day; thereafter a reduction of 5 per cent for each additional 500 pounds.² Up to 1,000 miles, \$1.50; 15 cents for each 100 miles over 1,000.³ \$75 per round trip.

After completing its studies the committee recommended the general use of a standard system of air marking that conveys the necessary information to pilots in the simplest and most effective manner. Its findings and recommendations as to general requirements, air-marking insignia, location, illumination, etc., were published on January 23, 1929, in a bulletin entitled "Report of Air Marking Committee."

SCENIC TOURS

During the past year there has also been an increased public support of scenic flights and air tours. These tours are the natural evolution of the "joy hops," which, while still exceedingly popular, no longer satisfy those who formerly desired only the thrill of their first airplane ride. These scenic trips are now being made from numerous cities and over many of the Nation's more picturesque spots. Some of these include the Grand Canyon, Yellowstone Park, Mount Rainier, New York City, Washington, and other points of recognized interest.

SURVEY OF EUROPEAN AIRPORTS

The Director of Aeronautics of the Department of Commerce visited during the past year all the more important aviation centers in Europe. The scientific study of European airport management and administration made available to the United States numerous principles as to (1) type of ownership, or the extent of control over the airport as a unit; (2) the physical layout including area, buildings, equipment, etc.; (3) the nature and extent of aircraft; and (4) the uniformity of airport rules and regulations when considered nationally or internationally.

As a result of this survey, three factors were found to be fundamentally applicable to American airports: (a) Adequate jurisdiction with qualified executives in charge; (b) definite control of all activities, including segregation when possible and advisable; and (c) uniform rules and regulations governing the operation of aircraft in the vicinity of the airport, and in landing and taking off. If a competent executive with suitable authority exercises intelligent control over all activities, in conformity with uniform requirements, the problems of airport management can be successfully handled without difficulty.

EQUIPMENT-DESIGN PROGRESS

Numerous notable advances in aircraft construction, design, and accessories have been made during the past year. Into the plane itself has been built much of the inherent stability hoped for and promised by aeronautical engineers for many years. Moreover, this stability has been achieved without sacrificing maneuverability or controllability. Among the striking features of the year's development are the increasing number of multimotored transports, the increasing use of metal propellers and tail wheels instead of skids, the adoption by numerous manufacturers of the engine cowling developed by the National Advisory Committee for Aeronautics, the increased use of metal in wings and fuselages, the development of the Diesel engine for aircraft, and the attainment of increased speed by nearly all types of commercial aircraft. Another striking feature of late development has been the general application of brakes to airplane wheels. Not only does this development greatly reduce the landing roll and take-off distance but it also aids materially in maneuvering an airplane on the ground as the brakes are independent in action. Landing gears of oleopneumatic and oleospring design, too, are now being used almost exclusively for shock-absorption purposes and are proving extremely successful in improving landing characteristics. There is a general tendency to substitute metal for all parts of airplane construction. In fuselage design wood and wire construction have been almost entirely superseded by welded steel tubing or other metal. In the majority of instances wings continue to be built of wood spars and ribs with coverings of fabric; but a number of manufacturers are giving attention to the construction of all-metal planes with a very thin sheet of duraluminum replacing the fabric and several of these designs are now in extensive commercial use.

TABLE H.—Aircraft and engine census by types, 1928 (calendar year)

AIRCRAFT

Kind	New construction		Rebuilt and reassembled		Total value
	Number	Value	Number	Value	
Heavier than air:					
1, 2, and 3 place open cockpit.....	3, 114	\$19, 896, 073	116	\$198, 220	\$20, 094, 302
Small transport, mail and express, open cockpit.....	86	954, 544	26	241, 803	1, 196, 347
Cabin, single engine.....	902	9, 132, 460	20	59, 138	9, 191, 598
Cabin, multimotored.....	114	5, 361, 644	1	3, 500	5, 365, 144
Amphibian.....	111	2, 565, 600			2, 565, 600
Seaplanes, all types.....	18	577, 518	1	5, 000	582, 518
Lighter than air:					
Airships.....					
Balloons—					
Captive.....					
Free.....					
Parts (other than engine).....		4, 714, 547			4, 714, 547
Repair work.....		609, 932			609, 932
Total.....	4, 346	43, 812, 318	164	507, 670	44, 319, 988

ENGINES

Engines (aircraft only):					
Radial, 1-150 horsepower.....	621	\$592, 217	25	\$23, 000	\$616, 217
Radial, 151-400 horsepower.....	1, 547	6, 041, 316			6, 041, 316
Radial, 401 horsepower and over.....	1, 073	7, 987, 975			7, 987, 975
All other types, 1-150 horsepower.....	11	15, 975	65	40, 000	55, 975
All other types, 151-400 horsepower.....	9	13, 700	604	356, 727	370, 427
All other types, 401 horsepower and over.....	235	2, 157, 981	6	7, 152	2, 165, 133
Spare parts.....		2, 812, 216			2, 812, 216
Repair work.....		294, 244			294, 244
Total.....	3, 496	19, 915, 624	700	426, 879	20, 342, 503

Until recently the large supply of engines left over from the war materially retarded America's development of aircraft engines; now, however, this supply is virtually exhausted and large numbers of new engines are being developed to meet the demand of a strong market. Most of these new engines are of the fixed radial air-cooled type, primarily because this type possesses the advantages of lightweight, comparative simplicity of installation and maintenance, and high reliability. Several new vertical line engines, however, are being developed.

Exhaust manifolds have been receiving considerable attention in an effort to reduce noise as well as to carry exhaust gasses clear of the passenger compartment. Extensive study has also been devoted to the development of linings for airplane cabin interiors, which will reduce the noise of propeller and exhaust carried to the passenger's ears. Through improved installation of intake and exhaust manifolds, together with the mandatory utilization of fire walls and the elimination of air-pressure fuel-feed systems, the possible risk of fire in the air has become almost negligible.

Because of the lower cost of two and three place open cockpit by-planes, this type of aircraft continues to be the most popular; but the general trend in larger airplanes continues to be toward the monoplane and biplane cabin types.

TABLE I.—Aircraft products, by number and value, calendar years 1919-1928¹

Item	1928	1927	1926	1925	1923	1921	1919
Aircraft industry.....	\$64,662,491	\$21,161,888	\$17,670,403	\$12,524,719	\$12,945,263	\$6,652,981	\$14,372,643
Secondary products of other industries.....	(5)	452,535	24,500	230,462	197,101	777,843	(5)
Total value.....	64,662,491	21,614,388	17,694,905	12,775,181	13,142,364	7,450,824	14,372,643
Airplanes:							
Number.....	4,217	1,888	1,125	711	505	290	432
Value.....	\$35,847,391	\$12,224,979	\$7,448,679	\$5,908,335	\$6,166,218	\$3,818,340	\$3,466,452
Seaplanes and amphibians:							
Number.....	129	107	61	78	82	12	230
Value.....	\$3,143,118	\$2,280,020	\$1,422,348	\$765,324	\$1,570,851	\$314,768	\$4,590,016
Under construction at close of year (both classes):							
Number.....	(5)	(5)	508	259	281	374	341
Value.....	(5)	(5)	\$2,377,769	\$1,428,447	\$1,339,737	\$966,322	\$1,658,670
Parts and engines, value.....	\$24,335,927	\$5,037,519	\$4,683,973	\$3,794,885	\$2,830,294	\$901,619	\$2,601,995
All other products, including repair work, value ¹¹	\$1,336,055	\$2,071,870	\$391,136	\$878,100	\$1,226,264	\$1,429,775	\$2,065,510

¹ The census of manufactures was taken at 5-year intervals prior to 1919, but has since been taken at 2-year intervals. The census of the aircraft industry for 1926 was a special one. The statistics for the aircraft industry were not published in detail for years prior to 1919. At the census for 1914, 16 establishments reported the manufacture of aircraft and parts. The production of airplanes, seaplanes, and parts for that year was valued at \$481,022; the receipts for repair work amounted to \$209,481; and the value of "all other products" was reported as \$99,369. The data for any establishments engaged in the manufacture of aircraft in 1909 were included with those for manufactures of motor cycles, bicycles, and parts.

² The figures in this column are slightly higher than those previously published by the department, as additional reports have been added.

³ Not including output of 3 establishments with products valued at less than \$5,000 and of 5 engaged primarily in the manufacture of aircraft engines.

⁴ Includes \$10,993 reported by 4 establishments with products valued at less than \$5,000.

⁵ Not available.

⁶ Value of aircraft made by establishments engaged primarily in the manufacture of engines.

⁷ Parts only.

⁸ Not including 164 aircraft rebuilt or reassembled by the manufacturers.

⁹ Not including 150 planes built by individuals and firms engaged primarily in air-service operations.

¹⁰ An accurate census of aircraft-engine manufacture was made in 1928. It has been impossible to secure this information for previous years, as the majority of the data compiled by the Bureau of Census included reports on other types of internal-combustion engine reports.

¹¹ Experimental work, pontoons, airships, automobile bodies, sea sleds, and other miscellaneous items.

AIRCRAFT PRODUCTION

During the calendar year 1928 the establishments engaged primarily in the manufacture of aircraft built 4,217 airplanes, valued at \$35,847,391, and 129 seaplanes and amphibians, valued at \$3,143,118. The production in 1927 was 1,888 airplanes, valued at \$12,224,979, and 107 seaplanes and amphibians, valued at \$2,280,020.

Combined production of all classes of heavier-than-air craft—airplanes, seaplanes, and amphibians—increased from 1,995, valued at \$14,514,999 in 1927 to 4,346, valued at \$38,990,509 in 1928, the rates of increase being 117.8 per cent in number and 168.8 per cent in value.

Of the 94 establishments reporting for 1928, 16 were located in New York, 14 in California, 9 in Michigan, 8 each in Kansas and Illinois, 7 in Ohio, 6 in Missouri, 4 in Iowa, 3 in Pennsylvania, 2 each in Arkansas, Maryland, Oklahoma, and Texas; and 1 each in Colorado, Delaware, Minnesota, Nebraska, New Jersey, Rhode Island, Virginia, Washington, West Virginia, and Wisconsin.

During the year a total of 3,496 new aircraft engines were constructed whose value aggregated \$19,915,624. Aircraft propellers manufactured in 1928 numbered 14,358, of which 9,163 were wood, 4,809 metal, and 386 all other materials. Comparative figures for previous years are not available, as no previous census had been taken of aircraft engines and propellers.

EXPORTS

The trend in commercial aeronautics development throughout the world is borne out by foreign sales of United States aeronautic products during the calendar year 1928. Air-line developments and new uses for the airplane in this country, which has flying conditions as unfavorable as any part of the world, are as much responsible for the increased exports as were the long-distance flights of 1927.

Had the 1928 total of aeronautic product shipments from the United States been \$49,706 greater, which would have been attained with the export of one additional transport plane, the valuation for 1928 would have equaled the combined values for the previous three calendar years, when \$3,714,429 worth of aeronautic products were shipped or flown to foreign countries. Exports of the three aeronautic items—aircraft, engines, and parts—during the calendar year 1928 were valued at \$3,664,723, or 93 per cent over those for the previous year, and those in the first half of 1929 exceeded the aggregate for the full year of 1928 by more than 41 per cent.

In addition to the fact that 1928 was the record export year for United States aeronautic products, the increase for 1928 over 1927 was more pronounced than for any similar period. Aircraft exports advanced from 63, valued at \$848,568. in 1927, to 162, valued at \$1,759,653, in 1928. Canada took 62 airplanes as compared with 26 in the preceding year. Peru, which took only 8 airplanes in 1927, was the destination for 24 during 1928, while Mexico was the purchaser of 20 as compared with only 1. The fact that the American embargo was lifted on airplanes into China during 1928 accounted for 9 being shipped to that country. Latin America, including the West Indies, absorbed 75 planes, or 45 per cent of our total exports for the year, a fact which attests the increased interest of United States aircraft manufacturers in that important marketing area. Chile was the one South American country purchasing American aircraft during 1927 which made no purchases in 1928, but early this year there was a considerable movement of planes to that country because of a sale concluded last year.

TABLE J.—United States exports of aeronautical products, calendar years 1922-1929

Item	Number	Value	Item	Number	Value
1922:			1926:		
Planes.....	37	\$156,630	Planes.....	50	\$303,149
Engines.....	147	72,819	Engines.....	297	573,732
Parts for planes.....		265,481	Parts for planes.....		150,329
Total value.....		494,930	Total value.....		1,027,210
1923:			1927:		
Planes.....	48	309,051	Planes.....	63	848,568
Engines.....	80	65,558	Engines.....	84	484,875
Parts for planes.....		58,949	Parts for planes.....		570,117
Total value.....		433,558	Total value.....		1,903,563
1924:			1928:		
Planes.....	59	412,738	Planes.....	162	1,759,653
Engines.....	146	219,609	Engines.....	179	764,826
Parts for planes.....		165,926	Parts for planes.....		1,240,244
Total value.....		798,273	Total value.....		3,864,723
1925:			1929 (first half):		
Planes.....	80	511,282	Planes.....	199	3,290,949
Engines.....	73	170,793	Engines.....	178	830,282
Parts for planes.....		101,584	Parts for planes.....		1,053,525
Total value.....		783,659	Total value.....		5,174,756

Exports of airplane parts during 1928 reached a total value of \$1,240,244, or nearly 118 per cent above the 1927 figure of \$570,117. Canada heads the list of countries of destination for parts during 1928, taking over three times as many as in 1927. Soviet Russia in Europe continued to be among the principal markets for parts, and the increase in similar exports to China was 363 per cent greater than during the preceding three years.

Exports of airplane engines, although not showing so great an increase over 1927 as did airplanes and parts, advanced from a total of 84 engines, worth \$484,875, in 1927, to 179, valued at \$664,826, in 1928. The decrease in the average unit valuation is surprising and may be explained partly by the fact that in 1927 the higher-powered surplus war engines were being exported, whereas in 1928 these stocks had become about exhausted. Furthermore, during 1928 the lower-powered surplus war engines constituted the bulk of exports, which might account for the decrease in average unit value.

The gain in exports of aircraft engines and parts during 1928 is remarkable, not alone for its high percentage but for the fact that this was effected in the face of such obstacles as keen competition and the desire of each producing foreign country to further its own aviation industry through the use of its own products, a condition that is made more difficult by the fact that in certain foreign countries air-transport companies receive assistance from the Government in the form of subsidies which carry with them a stipulation that only domestic aircraft may be used, thus cutting off this outlet to American aircraft manufacturers.

Along with the exports of United States airplanes, the production figures of aircraft-producing countries are of significance, even if not always comparable; some giving statistics of value only, some of quantity only, and some of both. The United States production of

aircraft of all types for 1928 was conservatively 4,600, whereas, according to reliable estimates, France produced 1,440, Italy 475, Germany 352, and Switzerland 25. In 1927 the United Kingdom produced approximately 204 commercial airplanes.

It is known that during 1927 France exported about \$8,000,000 worth of airplanes, engines, and supplies, with Yugoslavia, Rumania, Switzerland, Germany, and Brazil the leading markets in order of importance; figures of unit exports from France in 1927 are not available. The United Kingdom's exports of airplanes, seaplanes, and parts for 1927 amounted to \$5,292,540, and in 1928 to \$7,434,700. Germany's exports of planes increased from 54 in 1927 to 61 during the first seven months of 1928. The United States was the leading market for German aircraft, taking 10. Brazil followed with 8. Italy and Switzerland with 5 each, and Austria with 4.

Because of the diversified uses to which airplanes are put in the United States, where there is a wide range in temperature and altitude, together with a comparatively large domestic market for aircraft, it would appear that the United States is peculiarly fitted to supply the world market for airplanes in much the same way it does now for automobiles.

AERONAUTICS TRADE COMMISSIONER

On July 1, 1927, an aeronautics trade commissioner for Latin America was appointed to cover the following work: (1) Promotion of sales of American aeronautical equipment; (2) maintenance of information service on aeronautics in Latin America; (3) dissemination of reliable information about aeronautics in the United States; and (4) the combating of monopolies, propaganda, influence, and competition prejudicial to the interests of the American aeronautics industry in Latin America.

While this commissioner is attached to the Bureau of Foreign and Domestic Commerce, an active cooperation is maintained with the Aeronautics Branch.

During the past fiscal year the work of the aeronautics trade commissioner and his assistant was effective in that both kept in touch with developments in that territory and were instrumental in paving the way for American air lines now penetrating the West Indies, Central America, and South America.

INTERNATIONAL CIVIL AERONAUTICS CONFERENCE

At the suggestion of the President of the United States, an international aeronautics conference was called to provide an opportunity for an interchange of views on problems pertaining to aircraft in international commerce and trade, and to commemorate the twenty-fifth anniversary of the first airplane flight. This conference was held in Washington, December 12-14, 1928.

Officials of the Aeronautics Branch of the Department of Commerce served on all but 2 of the 14 committees appointed for this international conference. Attendance at the conference included 77 officials and 39 unofficial delegates from foreign countries, 12 American official delegates, 32 American technical advisers, 43 committee members, and 238 representatives from American companies interested in the advancement of aeronautics.

As a result of this conference, highly illuminating facts and figures were obtained on the organization, economic and legal aspects of air transportation, aerial photography, private flying, airway development, operation and technical aspects of air transportation, air ports, meteorology, navigation, aeronautical research and installment financing of aeronautical equipment, development and control of tests, and trade in aircraft and aeronautical engines.

INTERNATIONAL CONVENTION ON AIR NAVIGATION

The United States was represented at the extraordinary session of the International Convention for Air Navigation by a delegation consisting of William P. MacCracken, jr., Assistant Secretary of Commerce for Aeronautics; Joseph R. Baker, assistant solicitor of the Department of State; John J. Ide, European representative of the National Advisory Committee for Aeronautics; Maj. B. K. Yount, assistant military attaché for air at Paris; and Lieut. Commander William D. Thomas, assistant naval attaché.

This conference was called by the International Commission for Air Navigation for the purpose of considering amendments to the convention, which might facilitate the adherence of the noncontracting nations. After considering numerous proposed amendments to the convention relating to the regulation of aerial navigation, dated October 13, 1919, the conference recommended amendments in articles 3, 5, 7, 15, 34, 37, and 41 and the deletion of article 42. At a regular session of the commission which was held immediately following the adjournment of the extraordinary session, these recommendations were concurred in; but before they become effective they must be ratified by all the contracting states. The extraordinary session was attended by delegates from 16 noncontracting nations: Austria, Brazil, China, Colombia, Cuba, Estonia, Finland, Germany, Haiti, Hungary, Luxemburg, Norway, Spain, Switzerland, Venezuela, and the United States.

In addition to attending these sessions the Assistant Secretary of Commerce for Aeronautics inspected aviation activities in France, Italy, Germany, Netherlands, Belgium, and England. In each of these countries he called on the respective heads of civil aviation and inspected their various activities which correspond to those of the Aeronautics Branch of the Department of Commerce and of the National Advisory Committee for Aeronautics. While in England he attended the international air exposition and delivered the Wilbur Wright memorial lecture entitled "Science and Its Relation to Aeronautics" before the Royal Aeronautical Society.

III. CONCLUSION

POLICY ADOPTED BY AERONAUTICS BRANCH

From the beginning, the Aeronautics Branch has adhered to its policy of assisting in bringing about a combination of four essential elements: (1) Airworthy aircraft, adequately equipped and efficiently maintained, (2) flown by competent pilots over (3) suitably equipped airways (4) in conformity with standard air traffic rules.

Since this policy has proved to be absolutely sound, it undoubtedly offers the best way of cooperating with the industry and also of bringing about public acceptance and use of properly established air commerce. It will, therefore, continue to be the basis for planning the activities of the Department of Commerce in the promotion and regulation of civil aeronautics, authorized by the air commerce act of 1926.

To carry out all the provisions of this act and the Bingham amendment of 1929, appropriations for the fiscal year 1929 aggregated \$4,361,850; and in addition part of the amount appropriated for the fiscal year 1928 was available for expenditure in the latter part of 1929. Despite the fact that air commerce increased in volume more than 100 per cent over the preceding year, thereby greatly increasing the volume of work devolving upon the Aeronautics Branch, the appropriations for this necessary work increased only 45 per cent. Virtually every division and section of the Aeronautics Branch, therefore, is handicapped by inadequacy of equipment and insufficiency of personnel for the increased volume of work.

Notwithstanding this handicap, it is generally conceded throughout the industry that the Department of Commerce is contributing materially to the advancement of civil aeronautics, to the creation of a powerful reserve of aerial defense for use in time of war, and to the development of a nation-wide network of air transport lines for use in time of peace.

It is the chief function of the Department of Commerce to develop America's commerce and industry, and the particular function of the Aeronautics Branch is to assist in the development of a new industry (1) which will provide employment for a constantly increasing percentage of the population; (2) which will serve as a potent agency for peace by more closely knitting together the various nations of the world; (3) which will provide a reservoir of aerial defense; (4) which will speed the movement of men, money, mail, and merchandise; (5) and which will decrease the costs of distribution and thereby increase the purchasing power of the consumer's dollar.

Because every person and business in the United States is paying continuously for the transportation of people, ideas, or merchandise, it is readily apparent that any reduction in the cost of transportation, any improvement in speed or convenience, any advance which will reduce the toll of loss occasioned by slower and older forms of transportation, will prove of direct benefit to each firm and individual in the Nation.

Since many millions of dollars worth of money, mail, and merchandise are "in transit" every day in the year, it is immediately apparent that each minute of reduction in this dead-loss transit time will effect a saving in the necessary costs of doing business.

Hand-to-mouth buying, which is admittedly a prime factor in America's prosperity, will be greatly facilitated by the further development of air transportation. The more rapid transit provided by aircraft and airways will appreciably reduce the necessity for keeping huge sums of money tied up in slow-moving merchandise, will enable retailers to carry smaller stocks and thereby release capital for other merchandising activities, and will lower the costs

of transacting business and thereby add to the buying power of the public's income.

A nation-wide increase in our general prosperity seems certain, therefore, to result from the increasing development and utilization of air transport. To further this increasing development and use, it is highly important that the aeronautical work of the Department of Commerce be both expedited and expanded by necessary legislation and adequate appropriations.

Very truly yours,

CLARENCE M. YOUNG,
Director of Aeronautics.

RADIO DIVISION

DEPARTMENT OF COMMERCE,
RADIO DIVISION,
Washington, July 1, 1929.

The honorable the SECRETARY OF COMMERCE.

DEAR MR. SECRETARY: In response to your request I furnish the following condensed report of the work of the radio division during the past fiscal year, including references to related developments which have taken place during the year.

Under authority of an act of Congress approved March 4, 1929, all the powers and authority vested in the Federal Radio Commission by the radio act of 1927 are continued to be vested in and exercised by the commission until December 31, 1929. The radio division continues the inspection of all licensed radio stations, land and ship; examines and licenses radio operators; checks the frequencies of stations; measures the field strength of stations; and performs all of the field work necessary for the enforcement of the ship radio act, the radio act of 1927, and the International Radiotelegraph Convention of 1927. The radio act of 1927 limits the period of a broadcasting station license to three months and all other classes of radio station licenses to a period not exceeding one year. These licenses are issued by the Federal Radio Commission, with the exception of amateur and technical and training-school station licenses which are issued by the radio division by authority of the Federal Radio Commission.

RADIO INSPECTION SERVICE

During the fiscal year 10,715 inspections were made of radio installations on American and foreign vessels clearing from our ports as compared with 9,093 the previous year. The inspections made developed 335 cases of defective apparatus, lack of proper equipment or personnel, etc. There were 15,023 clearances of such vessels as compared with 14,305 during the previous year. There were 1,102 inspections of ship stations for license as compared with 1,139 the previous year. There were 1,154 inspections of commercial land stations and 229 inspections of amateur stations as compared with 866 and 184, respectively, the previous year. Examinations were given 3,477 applicants for commercial operators' licenses and 3,163 applicants for amateur operators' licenses. During the year offices were established at Kansas City, Mo., St. Paul, Minn., Dallas, Tex., and Los Angeles, Calif. Consideration has been given to locating offices at Denver, Colo., Hawaii, and Alaska. This can not be accomplished until additional personnel is available and some additional equipment is obtained, although there is pressing need for them. It is hoped that Denver and Hawaii can be opened this fall and Alaska next spring.

It is expected there will be a considerable increase in the duties of the inspection service during the coming year, due to the extensive use of radio in the aviation service and the operation of numerous point-to-point commercial communication stations.

RADIO TEST CARS

The division now has in service six radio test cars, one assigned to each of the following districts: Third, Baltimore; fourth, Atlanta; fifth, Dallas; sixth, San Francisco; eighth, Detroit; ninth, Kansas City. Two additional cars are urgently needed for the first district, Boston, and the seventh district, Seattle. Since the first car was purchased in 1925 the usefulness of these cars in our inspection work has been fully demonstrated. There has been no other way found to satisfactorily transport the inspection equipment and efficiently perform much of the inspection work. The cars provide a practical and satisfactory means of checking the frequency of the numerous small stations sharing the same frequencies. This can not be done from the headquarters offices when several stations are simultaneously using the same frequency. The cars also provide the only means of measuring the field strength of radio transmitters and determining the dependable service area of stations. The strength of harmonics is also measured in this manner.

MONITORING BROADCASTING STATIONS

With apparatus constructed by the field inspection service, monitoring was carried on throughout the year in all inspection districts. The use of this equipment demonstrated the need for more precise instruments, and steps have been taken to procure them. It also proved the value of frequency measurements at fixed points rather than at the station being measured as was formerly the custom. This service has been of value to the Federal Radio Commission and has been helpful to station owners. Of the 614 licensed broadcasting stations, frequency measurements were made of 374 stations. The 240 stations not measured were mostly of low power, at a considerable distance from the monitoring stations, and stations operating simultaneously on shared frequencies, or operating mostly during daylight hours. To measure the frequencies of these stations it will be necessary to make use of test cars fitted with frequency-measuring apparatus, which will be possible during the coming winter when the apparatus now being manufactured for this purpose has been installed. Fixed-point measurements will be made at Boston, New York, Baltimore, New Orleans, Los Angeles, San Francisco, Portland, Detroit, Chicago, St. Paul, Denver, and Grand Island, Nebr. At the latter point the constant-frequency monitoring station will be situated. In addition to monitoring the commercial and private stations, our service will monitor the Government stations of any department of the Government desiring our assistance. When these monitoring stations are fully equipped and manned the measurements will not be limited to broadcast stations as heretofore, but will include the frequencies in use above and below the broadcast band. During the year there were 2,451 measurements made showing a deviation of

500 cycles or more from the assigned frequency of the stations out of a total of 22,450 measurements made of broadcasting station frequencies. There were 106 measurements showing deviations of 5 kilocycles or more, and of this number there were 59 deviations of 10 kilocycles or more.

CONSTANT-FREQUENCY MONITORING STATION

The department was authorized in an act approved February 21, 1929, to purchase a suitable site and to contract for the construction thereon of a building suitable for installation therein of apparatus for use as a constant-frequency monitoring radio station, and for the construction of a suitable roadway, power, and communication facilities, at a cost not to exceed \$50,000.

The site, comprising 50 acres of land, has been procured in the vicinity of Grand Island, Nebr., which is about the geographical center of the United States, where tests indicate radio-reception conditions to be favorable in all directions. The chamber of commerce at Grand Island has shown a real and helpful interest in our problem from the beginning of our effort to find a suitable site and is continuing its cooperation to the fullest extent.

The Navy Department, Bureau of Yards and Docks, prepared plans and specifications for the building and is continuing to give such assistance and advice as are needed in connection with the work.

It is expected that the building will be erected and the apparatus installed and in operation within a few months. The measuring apparatus to be installed in this station will be of such design that it will be capable of making measurements with a resulting accuracy of 1 part in 1,000,000. The primary source of frequency will be that of the earth's rotation derived through the United States standard of time, which is the Naval Observatory at Washington, from which standard time is transmitted twice daily. To further augment these standard time transmissions there will be installed at the constant-frequency station a master clock, operating in a heat-controlled chamber and under vacuum, accurate to a degree greater than one-tenth of a second. This method assures agreement with the recognized radio standard of the United States at the Bureau of Standards. This standard clock will be checked daily and kept in synchronism with the Naval Observatory clock.

An electrically driven tuning fork, controlled by the clock, serves as a basis for the establishment of the ultimate radio-frequencies to be developed. As an alternate, a piezoelectric oscillator will be supplied to perform the same service as the tuning fork. The frequency of the tuning fork which is relatively low, on the order of 5,000 cycles, is multiplied by means of harmonic multiplier circuits to radio-frequencies on the order of 30,000 kilocycles. The production of these radio-frequencies is accomplished in such a manner that harmonics are available at every 10 kilocycles throughout the radio-frequency spectrum. These standard frequencies are used as a means of measurement of unknown radio-frequencies in precisely the same fashion as described in the operation of the secondary standards of

frequency. The equipment involved in all operations is of a more precise nature due to the greater requirements of accuracy for this central station.

Three types of receivers are to be installed at this station, two of which cover the frequencies from 100 to 30,000 kilocycles; the third covers from 10 to 100 kilocycles, using both loops and antenna and having extreme selectivity and sensitivity. The arrangement of the receivers permits simultaneous use at all times. Each receiver is to be in a shielded booth. All power supplies, although generated on the premises, are to be filtered and shielded. The standards and receivers will be operated entirely from storage batteries, all provided in duplicate, and charged by means of small motor generators through suitable distribution systems connected to the main power plant.

A special antenna system, in conformity with the latest developments in this line, is to be erected. These antennæ are in the main to be of the type connected to receivers through radio-frequency transmission lines. Due to the large number of these antennæ and to the necessity of complete isolation from any device capable of causing interference with reception it has been necessary to secure at least 50 acres of land for the use of this station.

The station is to be built around a room having 2,000 square feet of floor space in which will be installed all of the standard equipment and receivers. In addition to this large room there will be rooms to be used for dormitories, kitchen, workshop, office, storage batteries, motor generators, and switchboards. An adjacent building will provide garage space and power plant. Every effort has been made to make the station complete in itself, so that 24-hour-a-day service will be insured throughout the year.

SECONDARY STANDARD OF FREQUENCY MONITORING

The secondary standards of frequency now being developed for the division obtain their fundamental source of frequency from a piezocrystal with temperature carefully controlled. This crystal is electrically connected with the 10-kilocycle oscillator and controls it. The 10-kilocycle oscillator is a device rich in harmonics, furnishing them every 10 kilocycles between the limits of 30,000 and 10 kilocycles. Since these numerous frequencies are furnished by an oscillator controlled by the crystal oscillator their accuracy is supposed to be of the same order as that of the fundamental control frequency.

The beat frequency indicator is a device which furnishes indication in a visual form between various circuits and is primarily a resonance indicator capable of use to a great accuracy.

The audio-frequency oscillator operates between the frequencies of approximately 60 and 15,000 cycles. Its use is the accurate determination of the difference between unknown frequencies such as those of the transmitting stations to be measured and the known frequencies supplied from the control oscillator.

The heterodyne frequency wave meter is an oscillating wave meter which is used for the identification of individual 10-kilocycle harmonics. It is a device having fundamentally a straight line curve permitting the standard frequency identifications to be made quickly and accurately.

The tuning-fork calibration meter furnishes a means of either calibrating or determining the state of calibration of the audio-frequency oscillator. It is really a device supplying a sufficient number of known accurate audio-frequencies by means of which the calibration curve of the audio oscillator may be either drawn or checked.

The above equipment is to be used for the measurement of frequency of any radio transmitter in the following manner: Signals are tuned in from the transmitter on the proper receiver, a description of which follows later, and are put through the following operations: The output from the receiver is heterodyned or mixed with the output of the 10-kilocycle controlled oscillator. Since this oscillator has harmonics all through the radio-frequency spectrum, one of these harmonics will beat with the output of the receiver producing an audio-frequency whose value is dependent on the difference or sum between the transmitter's frequency and the proper harmonic. The order or value of this harmonic may then be determined by means of the heterodyne frequency meter. The beat frequency produced between the harmonic of the 10-kilocycle oscillator and the transmitter may then be measured by means of the audio-frequency oscillator. This amounts to merely varying the frequency of the audio oscillator until its frequency is exactly the same as that of the beat frequency mentioned above. We now know exactly the difference between the standard frequency and the transmitter frequency. Inasmuch as the transmitter frequency may be either above or below the standard beating harmonic from the 10-kilocycle generator, it is necessary to either add or subtract this difference from this harmonic. Whether it should be added or subtracted is determined by the use of the heterodyne frequency meter which is heterodyned with the incoming signal, and since it was previously heterodyned with the beating harmonic a glance at the curve of the instrument will indicate which way the transmitter frequency lies. In all of these operations each zero beat, whether between audio or radio frequencies, has been determined by means of the zero beat indicator furnishing visual indication, and also by means of a loud speaker furnishing audible indications. A brief summation of the operations outlined above would be that, to measure an unknown frequency, the unknown frequency is heterodyned with a standard known frequency. The difference between the known frequency and the unknown or transmitted frequency is measured by means of an audio oscillator exactly synchronized with the difference between the two.

The receivers to be used at the secondary standard stations consist of two units, one operating between the frequencies of 1,500 and 100 kilocycles, the other operating between the frequencies of 1,500 and 30,000 kilocycles. The receiver mentioned first consists of four stages of individually tuned radio-frequency amplification. Plug-in coils are used to cover the wide range. The selectivity of this receiver is such that it is possible to receive without interference stations on each of the 10-kilocycle channels throughout the broadcast band. The sensitivity of the receiver is such that it will respond to signals of less than 1 microvolt per meter level and furnish a good loud-speaker signal at this value. The audio-frequency section of the receiver furnishes reproduction throughout the entire audio range of frequencies up to 10,000 cycles and works in to a special dynamic type of loud speaker giving high-quality reproduction. Regeneration in the de-

tector circuit of this receiver is supplied to further increase the sensitivity of the set and to make possible the reception of continuous wave signals. This receiver operates from both loops and antenna throughout its range.

The high-frequency receiver which operates over the range of 1,500 to 30,000 kilocycles is a radio-frequency receiver having three stages of screen grid individually tuned amplification. This receiver is an extremely selective and sensitive device, furnishing loud-speaker response on radio signals of a level considerably less than 1 microvolt per meter. Regeneration is supplied in this receiver to increase its sensitivity and to make possible the reception of continuous wave signals. The audio-frequency portion of the receiver as well as its loud speaker is identical with that described above.

The power supply for the secondary standard of frequency, its associated equipment, and the receivers as outlined above, is derived entirely from storage batteries. All batteries are supplied in duplicate both for filament and plate supply. These batteries are kept in a state of charge by means of two high-voltage motor generators and one low-voltage motor generator. All charging and discharging are done through a switchboard which furnishes indications of the various rates of charge and discharge at all times.

The total secondary standard of frequency, as described above, is a complete unit for the reception and measurement of any frequency between 100 and 30,000 kilocycles. The accuracy of measurement is such that a result of at least 1 part in 100,000 may be secured.

These secondary standards are to be placed in each of the radio inspection districts. Six of them will be placed on the six test cars now in service. They will supplement the service to be performed at the central station situated in Nebraska.

RADIO FOR AVIATION

There are now 97 planes equipped with radio apparatus. Radio transmitting licenses have been issued to 34 airports; in addition there have been issued 44 construction permits for airports to be equipped with radio transmitters. From the radio standpoint, this service is just getting started and is expected to expand rapidly.

Following are some pertinent extracts from a report submitted by a commercial aviation committee on radio:

It is anticipated that the safeguarding of life and property in aviation will be largely dependent upon radio communication, radio navigation, advising pilots regarding weather conditions, directing pilots to landing fields, guiding pilots during periods of poor visibility, and enabling pilots to land. Due to the nature of the service rendered, radio is the only means for handling communications to and from aircraft in flight. At present in the United States there are approximately 3,000 landing fields in operation or under construction and about 20,000 planes of all classes in use. Several overseas aircraft routes are projected.

Radio stations in this important and rapidly developing service must be inspected and protected from interference. Safety of life and property is largely dependent upon reliable radio communication, and the inspection service of the radio division will be relied upon to aid in protecting this service from interference. The personnel and facilities of the radio division are far from being adequate to meet the demands being made upon it. It is essential that increased facilities be made available through larger appropriations for this service;

otherwise its duties can not be performed as they should be, even though the personnel continue working overtime in the future as they have in the past.

RADIOBEACONS AND RADIO COMPASSES

For the purpose of better safeguarding navigation, particularly in foggy weather, when the greatest need for aid exists, the Bureau of Lighthouses has in operation 23 radiobeacons on the Atlantic coast, 15 on the Pacific coast, 6 on the Gulf coast, and 21 on the coasts of the Great Lakes. These beacons are located in the lighthouses and light vessels. The transmitters send out characteristic signals composed of dashes and dots which serve to identify each beacon. This service is available to ships which are equipped with radio compasses. In other countries there are a total of 57 beacons.

Interest in the installation of radio compasses on ships is increasing rapidly. Because of the value of this apparatus as a navigational aid and its demonstrated usefulness in connection with locating vessels in distress it was agreed at the Safety of Life at Sea Conference held in London in April and May of this year that all passenger ships of 5,000 tons gross tonnage and upwards shall within two years from the date on which the convention comes in force be provided with an approved direction finding apparatus (radio compass).

Under the United States flag there are 718 commercial vessels and 375 Government vessels using radio compasses or a total of 1,093. There are 1,942 foreign vessels so equipped.

AUTOMATIC ALARM SIGNAL DEVICE

The Safety of Life at Sea Convention signed at London May 31 provides for the use of the auto alarm as a means of maintaining watch. This device may be used as a substitute for an operator or a watcher where more than one operator is required on a vessel. However, all vessels which are required to be fitted with radio installations, shall, for safety purposes, carry a qualified operator. Where the auto alarm is installed it must be in operation whenever the operator or watcher is not on duty. The auto alarm must meet the specifications set forth in the International Radiotelegraph Convention of Washington, 1927. There are 5 types of auto alarm being manufactured—3 British, 1 French, and 1 German. So far, only the British types are installed on ships and all are on British ships, with few, if any, exceptions. During the fiscal year, 688 inspections were made of vessels equipped with auto alarms and in 414 cases reports were made that the device had responded to signals not intended to actuate the apparatus.

RADIO BROADCASTING

The United States was the first country in the world to have radio broadcasting. The first broadcasting licenses were issued in the fall of 1921. Prior to this time a few special events were broadcast, but this form of transmission was carried on largely for the purpose of testing radiotelephone transmitters, which was usually done under experimental licenses. One of the earliest radiotelephone tests of which this office has a record, in connection with which phonograph

records of music were broadcast, was carried on by the Wanamaker, New York, radio station during May, 1914. Different types of hydrogen arc radiotelephone transmitters were used in these tests. Government departments, commercial radio companies, and amateurs were about the only ones having radio receiving sets at that time. One of these sets was installed in the office of the radio inspector, customhouse, New York, for the purpose of observing interference between amateur stations and ships. While engaged in this work the broadcast of music was detected. No one at that time had any idea of the future possibilities of broadcasting entertainment. About five years later experiments were being made with the tube type of radio transmitter. Listeners hearing the musical programs, and learning the source of them, sent in requests for more music which subsequently resulted in the inauguration of the service through stations built for this purpose. During the early days the programs of a majority of the stations consisted almost entirely of phonograph records. The announcers usually had favorite records which they repeated numerous times during a program.

The Secretary of Commerce foresaw the danger of the stations losing public interest if a change was not made in the programs. He ordered the creation of a new class of license requiring a higher standard in equipment, studios, and programs which immediately stimulated interest in the programs and resulted in rivalry among station owners to improve their stations and obtain one of the new high-class licenses. Thus was the foundation laid for the high-class broadcasting service we have to-day, which is far in advance of any country of the world as indicated by the increase in the number of receiving sets in use, approximately 60,000 in 1922 and approximately 10,000,000 at the present time. When an event of general public interest is broadcast it is reasonable to assume that it is available to more than half of the population of this country and a large number in other countries of the world.

From the beginning it has been recognized that the basis of granting a broadcasting license should be service to the public, and in no other way can an audience be held or a station prosper. There is no financial support for the operation of broadcasting stations derived directly from the listeners through the payment of a fee, such as is the custom in many other countries. For instance, in Great Britain there is an annual tax on the use of receiving sets amounting to \$2.45. In France the rate is 5 cents per annum and in Salvador it is \$18 per annum. Canada charges \$1 per annum.

AMATEURS

At the end of the fiscal year there were 16,829 licensed amateur radio stations, a decrease of 99 as compared with the previous year, when there were 16,928. While other countries are worrying over the problem of controlling, taxing, and discouraging the few surviving amateurs they have, this country is constantly endeavoring to keep this large and useful group of experimenters engaged in useful and interesting work. The latest proposal they have put forward is a request for permission to carry on radiotelephone communication in the 20-meter band, from 14,000 to 14,400 kilocycles. If given this

privilege, the amateurs expect to carry on international radiotelephone communication in this high-frequency band.

In order to continue satisfactory operation under the restricted frequency bands imposed by the Washington convention, intensive technical development has been carried on by the amateurs during the past year. This, the American Radio Relay League reports, has resulted in marked advances in apparatus and methods. In March, 1928, the band 28,000 to 30,000 kilocycles, 10.7 to 10 meters, made available to amateurs in the Washington convention, was opened to their use in this country. They have given particular attention to work in this band, and two-way communication has been established between amateurs in this country and in Europe, South America, and New Zealand. European amateurs have succeeded in communicating from Europe to South Africa and India on similar frequencies. On their more useful frequencies, numerous amateur stations have now been in communication with as many as 50 foreign countries. There is an increase in amateur interest in radiotelephony and many amateurs now seek an opportunity to duplicate by voice the long-distance work which they have successfully accomplished by radiotelegraphy.

The amateur again demonstrated his great value as a means of emergency communication to storm-stricken communities during the West Indian hurricane in September, 1928. At the Virgin Islands, when the Navy station was destroyed, one of the operators who maintained an amateur station put his set on the air and broadcast a warning to the United States in advance of the disturbance. As a result, amateurs in Florida and other Southern States had established emergency communication routes before the storm had reached this continent. Particular credit is due to two amateurs at Palm Beach who, although they lost their homes and personal belongings, put their amateur set into operation and for three days furnished the only means of communication with northern points from the distressed area. State, Army, and municipal authorities were high in their praise of this service.

In addition to emergency work, amateurs afforded home contact with many exploring and scientific expeditions.

INTERNATIONAL RADIO COMMUNICATION

Radiotelegraph and radiotelephone circuits now link the United States with the principal countries of the world. This service is being constantly improved and extended. Already it is far more extensive than that of any other nation. Much of this expansion and improvement are due to the successful use of short waves (high frequencies). Handling of increased traffic has been made possible by the development of directive, high-speed, short-wave apparatus.

In addition to the trans-Atlantic radiotelephone service, made available to the public January, 1927, there is soon to be inaugurated radiotelephone service between ship and shore and ship and ship. It is planned to provide a method for direct conversation between the residence or office phone and the stateroom phone on the ship.

PERSONNEL

The division is experiencing much difficulty in obtaining employees in the inspection service having the essential qualifications considered necessary for the performance of the highly technical duties required of this service. There are 18 vacancies to be filled. The Civil Service Commission held a special examination throughout the United States on January 15, 1929, which resulted in obtaining 14 eligibles from a total of 44 who took the examination for the position of assistant radio inspector. Only three of these men were willing to accept appointment. The Civil Service Commission has authorized the filling of existing vacancies by temporary appointments pending the establishment of another list of eligibles. Commercial companies are employing men with similar qualifications and are offering better salaries. The supply is not equal to the demand in this highly technical and specialized field, therefore our service will be at a disadvantage until the salaries more nearly compare with commercial salaries.

I renew my previous recommendation that the following classification of positions and salaries be made applicable to the field-inspection personnel:

Supervisor (senior)-----	\$5, 600-\$6, 400
Supervisor (junior)-----	4, 600- 5, 200
Assistant supervisors-----	3, 800- 4, 400
Inspectors-----	3, 200- 3, 700
Assistant inspectors-----	2, 600- 3, 100

A true indication of the need for additional personnel is shown by the number of hours overtime worked by 56 inspectors, which was 601 days during the year, and the amount of annual leave these men were able to take, which was 686 days during the year—average overtime per man 10% days, average leave per man 12¼ days. The above annual leave was not given to compensate for overtime, but ordinary leave granted all employees.

INTERNATIONAL CONFERENCES

A representative of the radio division attended three international conferences during the year. The first one was held at Ottawa, Canada, in January, where arrangements were made by representatives of Canada, Cuba, Newfoundland, and the United States to use certain short waves or high-frequency channels for national services in such manner as to avoid international interference. Mexico was invited to send a representative, but it was not convenient for him to attend at the time arranged. However, the requirements of Mexico were given careful consideration and a share of the waves was provided for the use of Mexico.

The second conference was held at Prague, Czechoslovakia, in April. This conference limited its deliberations almost entirely to subjects affecting European broadcasting and particularly to a new plan of frequency assignments for European broadcasting stations. Several other subjects of technical character were discussed, but as they were of international interest it was decided that they be referred to the international technical consulting committee on radio created by the International Radiotelegraph Convention of Washington, 1927. This

technical committee will hold its first meeting at The Hague in September, 1929.

The third conference was held at London, beginning April 16 and closing May 31. This conference dealt with subjects relating to safety of life at sea, an important one of which is radio. As a result of this conference the number of vessels required to be equipped with radio is materially increased. Passenger ships of 5,000 gross tonnage and upwards, if engaged in international service, must be fitted with radio direction-finding apparatus (radio compass). Where ships in the international service carry more than 13 lifeboats, 1 shall be a motor boat, and where the number is more than 19, 2 shall be motor boats. These motor lifeboats shall be fitted with a wireless telegraph installation. The radiotelegraphy provisions of the convention apply to all ships engaged in international voyages except cargo ships of less than 1,600 tons gross tonnage. All ships covered by the convention must carry at least one licensed operator, but continuous watch may be maintained by the use of an automatic alarm, provided such device complies with the requirements specified in the International Radiotelegraph Convention of Washington, 1927.

INTERNATIONAL RADIO ACCOUNTING

Since July 1, 1924, it has fallen to the lot of the radio division to carry out the provisions of the London Radiotelegraph Convention of 1912, to which the United States is signatory, with reference to settlement of accounts for tolls arising from the exchange of radio traffic between vessels of American registry and foreign coastal and ship stations. Messages originating in the United States and addressed to vessels of any nationality via radio are also charged to the United States by foreign administrations. Collections and settlements therefor are made through the accounting section of the radio division.

The activities of the accounting section of the radio division during the fiscal year from July 1, 1928, to June 30, 1929, may be summarized as follows:

Number of accounts handled:	
On hand July 1, 1928.....	701
Received during year.....	1,100
Total.....	1,801
Settled and cleared.....	1,045
Accounts on hand and unsettled June 30, 1929.....	756
Financial operations required to complete activities summarized:	
Cash balance, July 1, 1928.....	\$61,863.31
Collections.....	62,773.74
Total.....	124,637.05
Disbursements.....	80,117.24
Cash balance, June 30, 1929.....	44,519.81

Efforts of the nations signatory to the London Radiotelegraph Convention of 1912 have been directed in late years toward expediting settlement of accounts of the classes described. Special efforts have been made by the accounting section of the radio division to keep the accounts constantly moving in order that they may be held only

long enough to permit collection of charges due by American companies to foreign administrations. The cash handled represents collections only, as no appropriation account is involved in any way. The speed with which accounts may be settled with foreign administrations depends only on the completion of collections from American companies, inasmuch as no single account may be disbursed until all charges are collected. The cash balance at the end of each fiscal year represents partially collected charges on unsettled accounts.

Very truly yours,

W. D. TERRELL,
Chief Radio Division.

BUREAU OF THE CENSUS

DEPARTMENT OF COMMERCE,
BUREAU OF THE CENSUS,
Washington, July 1, 1929.

The honorable the SECRETARY OF COMMERCE.

DEAR MR. SECRETARY: I submit the following brief report of the work of the Bureau of the Census during the fiscal year ended June 30, 1929:

INTRODUCTION AND SUMMARY

While carrying on its regular periodical inquiries, involving the compilation and tabulation of data in regard to births, deaths, marriages, divorces, prisoners, patients in hospitals for mental disease, feeble-minded and epileptics in institutions, manufactures, electrical industries, financial transactions of States and cities, cotton ginning, and current production of numerous commodities, the bureau during the past year has had to give a great deal of study and work to plans and preparations for the great task of taking the Fifteenth Decennial Census, when it will be necessary to enumerate and to collect data for a population of more than 120,000,000, recording 25 or 30 items as to age, nativity, occupation, etc., of each individual; for more than 6,000,000 farms gathering details as to acreage, value of farms, crops, livestock, etc.; for about 200,000 manufacturing establishments, with information as to number of employees, value and quantity of products, horsepower, material used, etc.; for about 20,000 mining enterprises; for perhaps 2,500,000 establishments engaged in trade, collecting data as to number of employees and sales of various commodities; for an unknown number of persons unemployed at the time of the census; and for an indefinite number of drainage or irrigation projects or enterprises.

The preparatory work involves planning the organization and selection of the field force to be employed in taking the census; dividing the entire territory of the United States into districts of suitable size for the census purposes; defining or mapping the boundaries of these districts; selecting and formulating the inquiries or questions to be carried on the schedules; and other tasks. The next census will include close to 20,000 questions or items of information regarding individuals, farms, and manufacturing, commercial, and other enterprises; and between now and the 1st of next April it will be necessary to print more than 40,000,000 copies of various schedules of inquiries.

FIFTEENTH CENSUS

The bill providing for the Fifteenth Census which, as stated in my previous annual report covering the fiscal year 1928, failed of passage in the last Congress was reintroduced when the Seventy-first

Congress met in special session last April, and after some amendments passed both House and Senate, receiving the signature of the President on June 18. It provides that "a census of population, agriculture, irrigation, drainage, distribution, unemployment, and mines shall be taken by the Director of the Census in the year 1930 and every 10 years thereafter." This list of subjects includes two—namely, distribution and unemployment—which were not covered by the census of 1920 and one of which, distribution, was never included in any previous census. The subject of manufactures, which does not appear in the above list, is provided for by a section of the law which directs that the statistics of manufacturing industries shall be collected and published for every second year after 1927. Under this provision of the law a census of manufactures will be taken in 1930 covering the year 1929, thus forming virtually a part of the Fifteenth Census.

The law provides that the census of population and agriculture shall be taken as of the 1st day of April. The Bureau of the Census, therefore, must have its organization completed and everything in readiness for taking the census when that date arrives.

The late date at which the law was enacted would not have allowed sufficient time for preparation if the bureau had not previously done a great deal of preparatory work in anticipation of the passage of the act. The greatest preparatory task is that of defining and mapping the enumeration districts. The geographer's division in the Bureau of the Census had been working on this task for more than a year; and in order to carry on that work the force employed in that division had to be increased from 58 to 255.

The law provides that the enumerators must complete their work within two weeks in all cities having over 2,500 inhabitants and within 30 days in all other places. In order to complete the enumeration in the time thus prescribed by the law it will be necessary to employ over 100,000 enumerators. In cities the enumerators' districts should be laid out so that each, as a rule, will include a population of about 2,000 as estimated. In rural districts, where the population is sparse, or relatively so, it will not be possible for the enumerator to enumerate that number of people within the time prescribed by law, especially as he has the task of obtaining the census data for farms as well as for the inhabitants in his district. Accordingly, the rural district normally includes a smaller population but covers a larger area.

In my last previous report I referred to the correspondence that was being carried on with persons or organizations in all parts of the United States, including practically every county and township, for the purpose of obtaining information that would assist the bureau in defining the enumeration districts and determining the rates of pay which the enumerator should receive. This correspondence is now practically completed. Approximately 85,000 persons have been communicated with and the great majority of them have furnished the information which the bureau requested.

As a further preliminary to the laying out of enumeration districts, it is necessary to obtain a correct list of the minor civil divisions of the county—such as townships, precincts, and election districts—and to procure correct maps showing the boundaries of these divisions;

also correct and up-to-date maps of cities, indicating clearly the streets and boundaries. During the past year 6,900 city or county maps were secured, leaving 300 cities or counties for which maps are still to be obtained, if possible. For some of these no maps are in existence. But the use and importance of base maps in connection with the coming census have been so emphasized that many local governments have arranged to prepare such maps for our use.

Enumerators' districts have now been established for about 2,000 counties and for 54 of the 72 cities which had a population of over 100,000 in 1920, leaving about 1,000 counties and 28 cities for which the work is not yet completed.

The law provides for the appointment of supervisors who are to have charge of the work of enumeration in their respective districts. There will be in all about 575 supervisors, which is a considerable increase over the number appointed for the census of 1920, when there were 372. Thus the number of enumerators under the charge of each supervisor will on the average be smaller than it was 10 years ago—a change which, it is believed, will promote efficiency and promptness in taking the census. On the average a supervisor at this census will have about 170 enumerators under his charge, whereas at the last census the average was about 230.

In past censuses the supervisors' districts, as a rule, have conformed to the boundaries of congressional districts, as the law provided that that should be the case so far as practicable. But this provision was not retained in the act for the Fifteenth Census; and it would obviously be impossible to make 575 supervisors' districts conform to the boundaries of 435 congressional districts. As a rule, however, each congressional district contains the headquarters of at least one supervisor's district.

The law provides that the supervisors and enumerators may be appointed by the Director of the Census without regard to civil service laws or the classification act of 1923. The bureau is daily receiving applications for appointments as supervisors; and every precaution is being taken to insure the selection of competent and intelligent men for this important task. On receiving an application the applicant is sent a copy of the general instructions for supervisors, a pamphlet of about 50 pages, with a request to read this and then to notify the bureau whether he still wishes to be considered an applicant for the position. This step is taken because it is believed that in many instances persons apply for this position without much idea as to what the duties of the office are, and possibly with the impression that it is something in the nature of a sinecure. There have been several instances in which the applicant, on receiving these instructions as to the duties of the office, has withdrawn his application. If he still wishes to be considered an applicant, he is sent an application blank together with a test schedule which he is required to fill out and return with his formal application. This is the same kind of a test that is given to the enumerators. The facts that are to be entered on this schedule are stated in the form of a descriptive narrative, and it is safe to say that no one could fill out the schedule correctly without having carefully studied the instructions. The test schedule, when received, is corrected in this bureau and a photostat copy of the corrected schedule is then mailed to the applicant for his

information. If he has satisfactorily passed the test and his record and credentials are likewise satisfactory, he is given an appointment.

While the law provides that the enumerators, like the supervisors, may be appointed by the Director of the Census, it provides also that the authority may be delegated to the supervisors; and in practice that is what will be done in most cases. All applications for appointments as enumerators, however, must be filed in Washington, and the test schedules as filled out by the applicants will also be sent to Washington where they will be marked and graded. The bureau will then send to each supervisor the applications and corrected test schedules of those applicants within his district who have successfully passed the test, from which list he will make his selections.

The work of the supervisors at the census of 1920 was, in some instances, delayed for the reason that they were unable to secure a sufficient number of enumerators. In order to forestall any similar difficulty at this census and to be able to supply the supervisors when appointed with lists of eligibles for the position of enumerator, the bureau is taking steps to insure a sufficient number of applicants, and up to date has received and placed on file the names of about 50,000 persons who have informally applied for employment as enumerators.

The bureau is giving a great deal of study to the matter of determining the scope of the census as regards details, or the items and questions that are to be carried on the schedules. In previous censuses the items to be covered have been specified in the census act. But the present law, while it specifies the main subjects to be covered by the census, leaves the question of detail to the discretion of the Director and the Secretary of Commerce under the provision that "the number, form, and subdivision of the inquiries in the schedule shall be determined by the Director of the Census with the approval of the Secretary of Commerce." This is probably wise, because the matter of adding a new question to the schedule or eliminating a question included in previous censuses is one which requires the judgment of experts and must be considered from many angles. There is grave danger of overloading the census with detail. One must consider not only the value of the information in itself but its relative value as compared with other information which might be obtained by some alternative question or questions. One must consider the probable degree of accuracy in the answer to the proposed question, and the practicability of obtaining the desired information through the agency of a census. It must be remembered that the enumerator does not by any means see or interview every inhabitant. He must get the data for all members of the family from the member or members who happen to be at home at the time of his call. The adult male members of the family are quite likely to be absent at their places of employment. The questions must be such as will be readily, accurately, and willingly answered by anyone whom the enumerator may find at home. That cuts out many topics of inquiry which would be of great value if only we could count on getting the correct answers without delay or embarrassment.

On this important matter of selecting and limiting the questions on the schedule the bureau is trying to get the best counsel available.

Advisory conferences to consider the scope and formulation of the schedules have been organized—one on the population, another, with a different personnel, on manufactures, a third on distribution, and a fourth on unemployment. In formulating the agricultural schedule, the bureau has been in constant conference with representatives of the Department of Agriculture.

The bureau is establishing cooperative arrangements with various organizations and Government bureaus, when they can be of service in connection with taking the census. It has made such arrangements with the Bureau of Indian Affairs for the enumeration of Indians on reservations; with the Foreign Service division of the State Department for the enumeration of American citizens employed in the foreign service of the Government; with the War Department for the enumeration of Army posts; with the Navy Department for the enumeration of the officers, sailors, and marines at naval bases and on Navy vessels; with the National Park Service for the enumeration of persons in the national parks; with the Bureau of Lighthouses for the enumeration of persons on lightships and in lighthouses that are not accessible to enumerators; with the Bureau of Navigation and steamship companies for the enumeration of persons employed on mercantile vessels; with the Bureau of Mines for the census of mines.

APPORTIONMENT OF REPRESENTATIVES

The census act contains a section relating to the apportionment of Representatives. It provides that after each census the President shall transmit to Congress a statement showing the population of the several States as ascertained by the census and also the number of Representatives to which each State will be entitled under an apportionment of the then existing number of Representatives (at present 435) by each of the following methods: (1) By the method used in the last preceding apportionment; (2) by the method known as the method of major fractions, which happens at this time to be the same as (1); and (3) by the method known as the method of equal proportions. Then if the Congress to which this statement is submitted fails to pass a law apportioning Representatives, the apportionment by method (1) as announced by the President goes into effect. In short, this section of the law provides for what may be called an automatic apportionment in case Congress fails to act. If, however, the statement required from the President is not submitted within one week after Congress meets in regular session following the census, these provisions of the law have no effect. So unless the Bureau of the Census is to bear the onus of nullifying the law, it must have the population count completed and the apportionment tables ready by the time Congress meets in December following the date of the census.

This is the first time since the passage of the act providing for the census of 1850 that a census act has contained a section regulating the apportionment of Representatives.

CENSUS OF POPULATION

Of the various subjects which have come to be included in the ever-widening scope of the decennial census, population is by far the most important and fundamental. It is an essential factor in the presentation of practically all statistics of social or economic phenomena. The data with regard to births and deaths, for example, would be of little value if we did not have the population figures as a basis for rates. Population data are likewise necessary for the interpretation of statistics of production, distribution, and transportation.

The first decennial census, taken in 1790, covered only population, and was little more than a count of the number of people, although five classes were distinguished in the tabulation of the returns on the basis of age, sex, color, and status (slave or free). In the census of 1920 there were about 20 classifications; and in their various combinations these result in literally hundreds of classes which are shown in the present-day census reports. Furthermore, the population figures must be published in more or less detail, not only for States and counties but also for cities, with their wards, for smaller incorporated places, and even for townships, election districts, etc.

The population schedule to be used in 1930 will in the main be the same as that used in 1920 and earlier censuses. Most of the questions are standard questions, basic and essential in any census of population, such as age and sex. No one would think of omitting them; and conservatism in making changes is advisable because much of the value of the information obtained in each decennial census depends upon its comparability with information obtained in previous censuses. Nevertheless in this, as in every previous census, there will be some modifications and innovations to meet changing conditions and new interests.

Each census since and including that of 1850 has asked the nativity (State or country of birth) of each person enumerated; and in 1880 there were added questions calling for the nativity of each parent (father and mother). These questions will be retained on the census schedule for 1930. But it is proposed to omit the inquiry as to the mother tongue or native language of foreign-born persons and foreign-born parents, which was introduced in the census of 1910 and repeated in 1920. This question imposed a heavy additional burden on the enumerators and on the office force engaged in tabulation. It is believed that the questions as to the nativity and parent nativity permit an adequate classification by origin of the population of foreign birth or parentage, and that the added information that might be obtained by the mother-tongue question is not of sufficient value and reliability to justify the retention of that question, especially as the political boundaries of Europe now conform more closely to racial divisions than was the case in 1910.

For the information of the Veterans' Bureau two new questions have been proposed to ascertain whether the person enumerated is a war veteran and if so in what war he served.

Inquiry was made in 1920 as to whether or not the person lived on a farm at the time the census was taken, the answers to this question forming the basis for the statistics of the farm population. A second question, as to whether the person lived on a farm a year

ago, is to be added in 1930. The answers to these two questions, taken in conjunction, will afford the basis for statistics of migration to and from the farm.

Another new question on the population schedule is the one relating to unemployment, asking in regard to every person usually engaged in a gainful occupation whether actually at work at the time of the census. If the answer is "No," then, as explained later (see p. 92), a supplementary schedule carrying additional questions must be filled out for that person.

It is of far more concern that the data obtained once in 10 years through the costly process of taking a census shall be adequately tabulated and fully exploited than it is that the schedule of inquiries shall carry every item of interest that it is practicable to include. The population schedules of previous censuses contain a mass of valuable data that has never been utilized. In every census since and including that of 1850 there have been questions on the schedule that have never been tabulated at all. There have been other questions that were inadequately tabulated.

The population schedule contains not only data regarding the individual but equally valuable data regarding the family of which the individual is a member. The latter class of data has been entirely neglected in the past. It is hoped that this may not be the case in the coming census.

Accordingly tentative plans have been made for a family card to be punched after the work on the individual cards has been completed. On this would be punched the total number of persons in the family, the number of children, probably subdivided into two or three age groups, the number of boarders or lodgers, and the number of relatives or other dependents; the occupation of the head of the family; the number of gainful workers; and various other items of information about the family which are on the schedule but which have never before been tabulated. One purpose of the family card, among others, is to make it possible to tabulate the relative numbers of children in the families of the various racial groups and of various social classes as indicated by occupations.

CENSUS OF UNEMPLOYMENT

Inquiries with regard to unemployment were made and the results published in connection with the censuses of 1890 and 1900. Similar inquiries were made in 1910, but the results remained unpublished, along with considerable other material, for lack of funds. No question on unemployment was asked in 1920, but the Fifteenth Census act makes specific provision for such an inquiry in 1930.

Though the law refers to a census of unemployment as though it were to be a distinct investigation, the information must be obtained in connection with or as a part of the population census. So far as the plans have been worked out, there will be a question on the population schedule asking, for every person who usually works at a gainful occupation, whether or not he is at work on the day of the enumerator's call. There will be in addition a special schedule on which to record further information for each person reported as not at work.

An unemployed person is to be defined as one who is (*a*) usually employed, (*b*) out of a job, (*c*) able to work, and (*d*) looking for a job. Questions will be asked on the special schedule by which these persons can be distinguished from other persons not at work on the day of enumeration; and certain other classes, for example, those on strike and those on lay off without pay, will probably be shown also as supplementary items. It is believed that the tabulation of the cases where a man has a job but is not drawing pay will afford some index of the extent of part-time employment.

CENSUS OF AGRICULTURE

Agriculture has been one of the subjects covered by each decennial census since and including that of 1840. The act of 1919 providing for the Fourteenth Census, while perpetuating the inclusion of agriculture in the decennial census, provided that a census of agriculture should also be taken in 1925 and in every tenth year thereafter, so that the census of agriculture is now taken every five years.

Of all the schedules used in the decennial census the one for agriculture is the most elaborate. One reason for this is found in the variety of crops grown on farms in the United States. Information as to acreage and the quantity produced is sought regarding all the major crops and most of the minor ones. The various kinds of domestic animals on farms—cows, pigs, horses, etc.—must be separately reported and in more or less detail by age and sex. Other subjects covered in the schedule include the acreage of the entire farm and of certain classes of farm land such as crop land and pasture land; the tenure under which the farm is operated; the total value of the farm with separate items for buildings, for dwelling houses, and for implements and machinery; farm debt; principal farm expenses; land drained; farm machinery and facilities such as automobiles, tractors, telephone, radio, etc., each separately reported; and other data.

The information obtained by these inquiries is of incalculable value. But the schedule must be kept within workable limits and it is necessary, therefore, to guard against undue expansion and over-elaboration. The formulation and selection of the questions to be included in the next census are matters of great importance to which the bureau has been giving very careful consideration. Last December a joint committee composed of representatives of the Census Bureau and of the Department of Agriculture held the first of its meetings to prepare the schedules and outline plans for the censuses of agriculture, irrigation, and drainage. Many suggestions had reached the bureau relative to inquiries that it was thought should be included in the schedule. All of these suggestions were given careful consideration by the committee. Two preliminary farm schedules were presented for discussion, one containing 275 inquiries prepared by the census representatives, and the other containing 502 inquiries prepared by the Department of Agriculture representatives.

On January 30, 1929, the committee submitted a tentative farm schedule containing 375 inquiries as compared with 415 inquiries at the census of 1920, and 560 inquiries at the 1910 census. A schedule, containing 355 inquiries, was sent to the printer on April 25, and is now in proof. This contains over 50 new questions not carried in the census of 1920. On the other hand it omits about 110 of the questions

contained on the 1920 schedule, thus effecting a net reduction of about 60 items.

The following are some of the more important inquiries to be made for the first time at the census of 1930: Value of the farmer's dwelling house; such farm expenses as supplies and repairs for automotive vehicles, electric current, seeds and plants, and spraying and dusting materials; combines, electric motors, and gas engines on the farm; the number of days the farmer was gainfully employed in work not on his farm; the daily production of milk and eggs at the time of the census; and the number of baby chicks bought in 1929.

A large part of the questions carried on the schedule for 1920 but omitted from that for 1930 pertained to values of livestock and quantities of products sold or to be sold. The livestock values for 1930 will be computed from average price figures, by counties, to be furnished by the Department of Agriculture; and the quantities sold or to be sold will be reported for only a limited number of products.

The bureau plans to distribute 3,500,000 sample schedules to farmers prior to the date of enumeration.

The recent decennial censuses of agriculture have included an enumeration of livestock not on farms, the information being obtained on a separate schedule, which had to be carried by all the enumerators—those in cities and villages as well as in rural districts. The scope of this inquiry has been extended for the coming census to include chickens and bees not on farms.

At the urgent request of agricultural interests in the States of California and Florida, arrangements have been made for a very much more complete enumeration of subtropical fruits than has heretofore been made. For this purpose a tentative supplemental schedule containing 87 inquiries was prepared by the joint committee for use in 16 States. This schedule includes inquiries concerning grapes, by varieties, nuts, and certain fruits grown in the West, as well as subtropical fruits.

A supplemental schedule containing 250 inquiries has been prepared, on which are to be reported all irrigated crops. At former censuses the enumerator was instructed merely to check irrigated crops reported on the general schedule. The use of a separate schedule for this purpose is expected to yield more complete information on this subject.

Schedules for irrigation and drainage enterprises have been prepared by the joint committee of this bureau and the Department of Agriculture, to which a representative of the Bureau of Reclamation, Department of the Interior, was added for this purpose. The schedule for irrigation enterprises contains 80 inquiries, and that for drainage enterprises contains 60 inquiries. These schedules are now in the hands of the printer.

During the past year 32 special tabulations or compilations of data obtained in the 1925 census of agriculture have been made at the request and at the expense of various institutions, organizations, or individuals outside the Census Bureau. Six of these tabulations were made by employees of the Bureau of Agricultural Economics, Department of Agriculture, under the supervision of the Census Bureau. These were jobs of considerable size. In fact, one tabulation of farm data, crops and livestock for selected counties and townships in nine

States, for use in the study of types of farming, has been in progress for over two years, requiring the services of several clerks. Most of the other tabulations were made at the request of agricultural colleges or schools.

CENSUS OF MANUFACTURES

The biennial census of manufactures for the calendar year 1927 covered 201,001 establishments, comprising 169,325 engaged in the conversion of raw or partly manufactured materials into finished or partly finished products, 22,541 printing and publishing establishments, 5,962 laundries using power-driven machinery, and 3,173 establishments in the dyeing and cleaning industry. The manufacturers in general have a keen appreciation of the value of the census statistics, but, as at previous censuses, many of them were dilatory in preparing their reports, some of which were not received until late in 1928. The bureau was, nevertheless, able to begin the publication of the statistics early in 1928, and the census had been well advanced toward completion by the end of the fiscal year 1929, when 26 of the 64 reports, to be issued in pamphlet form, on individual industries or on small groups of closely related industries had been sent to the printer and the preparation of the other reports in this series was so far along that it is expected that the last of them will be ready not later than September 15.

The statistics are first issued in the form of mimeographed preliminary reports, each presenting the outstanding information for an industry, or in some cases for two or more related industries. In all, the bureau has issued preliminary reports covering 267 industries, besides a preliminary summary covering all industries by groups, and a report on prime movers in use in manufacturing industries. Following the publication of these preliminary summaries, the complete reports are being issued in the form of the printed pamphlets referred to above. These, together with certain additional material, will later be assembled for final publication in the form of a single octavo volume of approximately 1,500 pages.

In fulfillment of promises to local chambers of commerce, boards of trade, and similar organizations in return for their cooperation in the collection of the census data, summaries for the counties and cities in which these organizations are located were sent to them at the earliest dates possible, with permission to make such use of the figures as they might see fit. Thus, in many cases, statistics in regard to the manufacturing activities of counties and cities were first given to the press by the local organizations.

For census purposes manufacturing is classified into 340 industries, of which 226 were canvassed by means of special schedules, 152 in number, each adapted to some one industry or to two or more closely related industries, and the remaining 114 were canvassed by a general schedule. The number of industries canvassed by special schedules represents a great increase over the number, 119, thus canvassed at the census for 1925. The general schedule carries those questions which are applicable to all industries alike. The special schedule differs from it mainly in calling for additional detail regarding the products of the industry to which it relates, expressed in units of quantity so far as possible, as well as in value. This great increase

in the number of special schedules used has made it possible to compile and publish production statistics—the class of statistics for which the demand is the greatest—which are considerably wider in scope than those given in the reports for earlier years.

A census of manufactures has regularly been included in every decennial census beginning with that of 1840. The act of 1902 establishing the permanent Census Bureau provided that a special census of manufactures should be taken in the year 1905 and every 10 years thereafter. This action made the census of manufactures a quinquennial inquiry, since it continued to be included as a part of the decennial census. Then the act of 1919, providing for the Fourteenth Census, made the census of manufactures biennial, as it is at present. The next regular year to be covered by the biennial census, 1929, coincides with the year normally covered by the decennial census. Accordingly the 1929 census of manufactures, it may be said, will play a dual rôle, forming a part of the decennial census while continuing the series of biennial censuses. For this reason the scope of the next manufactures census may be somewhat expanded as compared with the previous biennial censuses.

CENSUS OF DISTRIBUTION

The provision for a census of distribution was incorporated in the Fifteenth Census act in response to a general demand for basic data that would throw light upon the important problem of eliminating unnecessary economic waste in the distribution of commodities. In most fields of production efficiency has increased amazingly during the last few years, and to a very large degree this is the result of the increase in statistical and other analytical knowledge of the operations of production. There has been no corresponding improvement in the field of distribution.

The average output per worker in production has increased 85 per cent since the beginning of the century and 34 per cent since the end of the war. We have no comparable figures to show the changes in efficiency in distribution, but the fact that production is taking a smaller and distribution a larger share of the consumer's dollars than before the war makes it quite clear that distribution has not increased in efficiency so rapidly as production.

There certainly is some relation between this situation and the fact that, while we have abundant data regarding production, we have very few dependable statistics covering the field of distribution. It is but natural, then, that business is now demanding that the Government should provide better statistics of distribution.

Much preliminary work has been carried on to determine the scope of the distribution census or the inquiries that it should carry. A number of conferences have been held with representatives of trade organizations, chambers of commerce, industrial organizations, statisticians, economists, and others interested in distribution problems for the purpose of securing their views and suggestions regarding the particular type of data required by business generally. These interviews developed the need of reliable information relating to the interchange of commodities by industry, with special reference to the industrial market for different classes of commodities used in further fabrication.

The test census of distribution taken in 11 cities in 1927 developed important facts in regard to the sales of commodities by retailers, wholesalers, brokers, and similar agencies. No effort was made at that census, however, to include data relating to the sale of commodities by one manufacturer to other manufacturers for use in assembling or for the purpose of fabricating other products. To determine the practicability of including industrial distribution in the national census a canvass was made in Cleveland in cooperation with the domestic commerce division of the Bureau of Foreign and Domestic Commerce. The questionnaire used called for the kind and cost of raw materials, semifinished products and completely manufactured parts, and mill supplies and fuel purchased and used by manufacturing establishments in Cleveland in fabricating products for sale, as well as the kind and cost of materials, equipment and supplies purchased for use in plant maintenance, extensions to plant and buildings, and plant operation. The questionnaire also included an inquiry showing the kind and volume of products sold by method of distribution, as follows: (1) Sold to wholesalers, jobbers, etc.; (2) sold to chain stores; (3) sold to retailers; (4) sold direct to consumers; and (5) sold to miscellaneous purchasers.

In cooperation with the domestic commerce division of the Bureau of Foreign and Domestic Commerce and the Louisville grocery survey a census of food outlets was made in Louisville, Ky.

The results of these censuses and the experience gained in making the canvasses will be taken into account in formulating plans for the national census.

Plans have been completed to organize an advisory committee and secure the assistance of men familiar with the different phases of distribution, to advise the bureau regarding the scope of the census, the form of questionnaires, methods of tabulation, form of presentation, and numerous problems incident to original research in this field of statistics.

In the cities the census of distribution will not be covered in the same canvass with the enumeration of the population, but will be taken at an earlier date by special enumerators selected for that work. But it is probable that the data for the country stores and other establishments in rural districts will be secured by the regular census enumerators employed in taking the censuses of population and agriculture in April.

CENSUS OF ELECTRICAL INDUSTRIES

The quinquennial census of electrical industries, covering central electric light and power stations, electric railways, telephones, and telegraphs, was taken for the calendar year 1927. The schedules were formulated in accordance with recommendations made by representatives of the electrical industries. The canvass was commenced promptly after the close of 1927 and was practically completed by the end of 1928.

Preliminary reports in mimeographed form, 49 in number, were issued during a period of approximately eight months beginning in September, 1928. The preliminary reports on central electric light and power stations presented statistics as to number of companies or systems, number of employees, expenses, output, equipment, etc., for

the United States as a whole and for the individual States. The reports on electric railways, telephones, and telegraphs were less comprehensive but summarized the figures of fundamental importance. The final reports will be sent to the printer before the close of 1929 and will be issued early in 1930.

As the quinquennial census of electrical industries and the biennial census of manufactures covered the same year, a special effort was made to prepare complete statistics on electric power. Data in regard to electric and other power in use in manufacturing industries are collected regularly at each census of manufactures. Thus the only special inquiry needed to make the presentation complete was the canvass of the so-called "isolated" power plants—plants operated by mines, quarries, hotels, amusement parks, etc. This was made by sending a very simple form of schedule, calling for data in regard to horsepower of prime movers, kilowatt capacity of generators, and number of kilowatt-hours of output, to the isolated plants which operated generators having a capacity of 100 kilowatts or more. It thus became possible for the first time, by combining the data for electric light and power plants proper, electric-railway power plants, electric power plants operated by manufacturing establishments, and the isolated electric plants, to calculate, with a fairly close approximation of accuracy, the total kilowatt capacity of generators in operation and the total output of electric current in the United States.

FINANCIAL STATISTICS OF STATE AND CITY GOVERNMENTS

Financial statistics of State governments.—On June 30, 1929, the work of collecting and compiling the financial statistics of the governments of the 48 States for the fiscal year ended December 31, 1928, was about 40 per cent complete. Preliminary summaries for the individual States are issued as rapidly as possible after the field work in each State is completed.

The copy for the 1927 report was transmitted to the printer November 23, 1928, and has now been printed and distributed.

Financial statistics of city governments.—The cities covered by this annual survey are those having a population of 30,000 and over as shown by the population census of 1920, or as shown by a special population census taken since that time. There were 250 cities in this class in 1928, and press summaries giving preliminary statistics for the fiscal year 1928 had been issued for 62 of these cities by June 30, 1928. The copy for the final report on this subject will be ready to go to the printer as soon as the summary for the last city is issued.

The copy for the 1927 report was transmitted to the printer January 31, 1929, and the report is now being printed.

For the fiscal year 1925 the plan of having some of the State and city officials fill out the census schedules was tried for the first time, and since that year the number preparing these financial statements has gradually increased. For the year 1928 the officials of 38 States and 154 cities agreed to do the work. Prior to 1925 it had been the practice of the bureau to have the financial statements for each of the 48 States and 250 cities included in the survey compiled by

trained employees of the bureau. The services of these employees are now required on work connected with the Fifteenth Decennial Census; therefore, it is necessary during the census period to have the majority of the State and city reports compiled by local officials. This plan of having the census schedules filled out by State and city officials was approved by the National Association of State Auditors, Comptrollers, and Treasurers at their annual meeting in November, 1928.

The National Association of State Auditors, Comptrollers, and Treasurers and the International Association of Comptrollers and Accounting Officers have appointed committees to confer with the bureau on methods of collecting and compiling statistical information relating to State and city governments. These committees were called in session last year, and in conjunction with the officials of the bureau in charge of the collection and compilation of State and city financial statistics, the schedules and books of instruction were revised to incorporate all needed changes.

CURRENT BUSINESS STATISTICS

The bureau during the past year has continued to compile and publish at regular intervals, usually monthly or quarterly, statistics regarding production of various commodities. The basic data are generally furnished directly by the producers without expense to the bureau.

The most comprehensive of these compilations and the one of longest standing is that relating to the production of cotton, or the cotton-ginning inquiry, which was established in 1900 and has been kept up ever since. This now requires the employment of about 700 field agents to send in the reports and an annual expenditure authorized by Congress of more than \$275,000. The scope of this inquiry has been described in my previous annual reports and there have been no developments or changes of any importance in regard to it during the past year.

The list of other commodities for which current data are collected includes fats and oils; hides, skins, and leather; boots and shoes; leather gloves and mittens; wheat and flour; wool and wool manufactures; hosiery and knitted underwear; clothing; pyroxylin-coated textiles; automobiles; railroad locomotives; electrical goods, electric industrial trucks and tractors, and mining and industrial electric locomotives; wood chemicals; paints and varnishes; oil burners; babbitt metal; boxboard; enameled sanitary ware; enameled and galvanized sheet metal ware; fertilizers; edible gelatin and animal glues; fire-extinguishing equipment; steel castings and malleable castings; steel barrels; mechanical stokers; fabricated structural steel, steel boilers, fabricated steel plate, and steel furniture; pumps, water systems, and water softeners; porcelain and vitreous-china plumbing fixtures; terra cotta and floor wall tile; etc.

SURVEY OF CURRENT BUSINESS

The monthly Survey of Current Business published by this bureau has appropriately been called the clearing house of business statistics, in that it brings together the current reports of business

activities issued by this bureau, as well as those compiled by other governmental agencies and representative private organizations, including trade associations. This monthly bulletin, which contains now approximately 1,800 individual statistical series, has definitely established its place in the field of current economic and statistical literature, being now perhaps the leading source of business statistics. It publishes figures covering production, stocks on hand, sales, prices, exports, imports, one or more of these or other business indices for each of more than 240 commodities. An increasingly large number of requests for figures on many subjects not now covered on a current basis evidences the increasing demand for statistical data on the part of business executives throughout the country. To keep pace with this growing interest in current figures, the Survey is aiming to broaden the scope of the inquiries so as to cover particularly such new industries as rayon, oil burners, radio, etc., with a view to filling in the statistical gaps which now exist. During the year the collection of monthly data from oil-burner manufacturers was authorized, a sufficient degree of cooperation from the manufacturers of this industry having been assured. Statistics on paints and varnishes, which hitherto had been reported to the bureau semi-annually, were studied with a view to providing this important industry with monthly data after assurances that the industry required current figures for the establishment of its own production and merchandising policies. These are but samples of the work which the Survey of Current Business is doing to help business help itself.

In my last annual report I referred to the Record Book of Business Statistics which, by presenting monthly figures so far as available from 1909 through 1926 on the various items shown in the Survey, is designed to furnish an historical background to the Survey by supplying data for earlier census years for comparison with recent or current data. Two parts of the Record Book, one covering textiles and the other covering metals and machinery, were issued during the fiscal year 1928. This last year Part 3, covering fuels, automobiles, and rubber, has been completed and sent to the printer.

The monograph on How to Use Current Business Statistics, which was prepared and published during the preceding year, has had a large sale, thus giving weight to the belief that further monographs concerning statistical problems might be prepared and published with profit to business and industry generally.

VITAL STATISTICS

In the United States the responsibility for the registration of births and deaths rests upon local and State agencies as established and controlled by State laws. The Federal registration area, for which statistics are compiled by the Bureau of the Census, comprises those States and Territories which are found to be receiving reports, under their own legal and administrative procedure, of 90 per cent or more of the births and deaths which actually occur. The completeness of reporting is measured in each case by a special test carried out by the Bureau of the Census. No State is eligible for this test until the model registration law or some equally satis-

factory law has been enacted by the State legislature and has been in force long enough to justify the belief that it is working satisfactorily.

At the present time South Dakota is the only State in the Union which does not have satisfactory birth and death registration laws. The effort to secure such legislation at the last session of the legislature failed in spite of the active support of the health authorities and the favorable recommendations of this bureau and of various State and national agencies interested in vital statistics. Texas and New Mexico have recently enacted satisfactory laws, and an intensive campaign to promote registration has been going on under the leadership of the State health authorities but with the very active cooperation of this bureau and of the committee appointed by the vital statistics section of the American Public Health Association. This committee combines the effectiveness and unifies the efforts of officials of the Census Bureau, the Children's Bureau, the United States Public Health Service, and other organizations, such as the American Red Cross, the Boy Scouts of America, the United States Chamber of Commerce, certain large insurance companies, the National Tuberculosis Association, and the International Health Board. The health officials of Texas and New Mexico are confident that their States will be able to meet the Federal requirements as to completeness of registration before the end of the calendar year 1929, and plans are now being made to carry out the test previously referred to.

Since my last report Nevada has been added to the death registration area, so that at present the area includes 45 States, and 10 cities in nonregistration States, a total estimated population of 114,572,000, or 95.5 per cent of the population of continental United States.

Colorado and Nevada have been added to the birth-registration area, and South Carolina has been readmitted, so that at present the area includes 45 States with a total estimated population of 113,426,000, or 94.5 per cent of the population of continental United States.

In 1927, the last year for which returns have been received and tabulated, there were 1,236,949 deaths in the registration area, or a death rate of 11.4 per thousand population, the lowest rate ever recorded by the bureau. In the same year there were 2,137,836 births, corresponding to a birth rate of 20.6 per thousand population. This rate, the same as 1926, is also the lowest recorded since 1915 when the birth registration area was established.

Two annual reports have been printed during the fiscal year, namely, *Mortality Statistics, 1925, Part II*; *Mortality Statistics, 1926, Part I*; *Births, Stillbirths, and Infant Mortality Statistics, 1925, Part II*; and *Births, Stillbirths, and Infant Mortality Statistics, 1926, Part I*.

In response to an invitation from the French Government, transmitted through the State Department, the bureau will send the chief statistician for vital statistics to the International Conference to be held in Paris in October, 1929, for the fourth revision of the International List of Causes of Death. In addition to the chief statistician I have designated six additional representatives of State and national agencies which are interested in the purpose of this conference. The International List, which is to be revised, is accepted

as the authoritative nomenclature throughout the civilized world. It has already been adopted officially by some 40 or 50 countries.

The work of revising the first edition of the Standard Nomenclature of Diseases and Pathological Conditions, Injuries, and Poisonings for the United States is progressing.

During the fiscal year the bureau has issued 112 mimeographed statements, with a total edition of 404,000, giving summaries of statistics covering births, deaths, infant mortality, and automobile fatalities. These include the Weekly Health Index, issued each Wednesday, which gives the number of deaths in each of the largest cities from which telegraphic reports have been received up to 11 a. m., on Tuesday, and the 4-week summary of automobile fatalities based on weekly telegraphic reports from the registrars of 78 major cities with a total population of approximately 33,000,000. The latest of these summaries is that for the four weeks ending June 15, 1929, which shows a death rate of 23.8 per 100,000 for the preceding 52 weeks as compared with a rate of 22.4 for the 52 weeks ending June 16 of the previous year. In addition, there have been mailed over 7,000 letters and approximately 2,000 packages.

The new forms for the standard certificates of birth and death have been approved by the vital statistics section of the American Public Health Association and by the Association of State and Provincial Health Officers, and distribution will be begun in ample time for use beginning January, 1930.

An ever-increasing use of the data collected and analyzed by the division of vital statistics is being made by insurance companies, foundations for research, and other agencies—official, semiofficial, and private. During the year the division has made 219 special compilations of data by request for 71 different organizations, the cost of the compilation, if appreciable, being met by the organization making the request. This does not include the many requests coming from private individuals engaged in research, from State or municipal governments, and from Members of Congress.

MARRIAGE AND DIVORCE

The statistics of marriage and divorce continue to be received by the public with a high degree of interest. The preliminary summaries, which are issued for the individual States as rapidly as the county officers have completed their reports, are given close study, as is attested by the hundreds of press clippings received. This is especially true of localities where rigid State laws have been enacted in an effort to curb hasty marriages or to make the granting of a divorce a more difficult proposition. The reports for the surrounding States are carefully scanned by the press of the country with a view of ascertaining whether or not the border counties show marked changes in figures, and the results are commented on at length.

It is unfortunate that lack of uniformity in the information recorded by the officials issuing marriage licenses in the various States prevents the publishing of anything further than the actual number of marriages performed in the United States, by States and counties. Many requests for additional data are received—particularly the age of the contracting parties. Fairly uniform information on a number

of subjects is obtained from court records with regard to divorces granted and marriages annulled.

The statistics of marriage are now obtained from some office of the State government in 29 States, and the statistics for divorce are likewise obtained from State officials in 16 States, with a prospect that 1 more State will be added to the list next year. In the other States it is necessary to obtain the information from county officials.

On June 30, 1929, the work of securing the information with regard to marriages and divorces in 1928 was about 90 per cent complete, reports having been received for 1,057,608 marriages, 180,674 divorces, and 3,930 annulments, as compared with a total of 1,201,053 marriages, 192,037 divorces, and 4,255 annulments for the year 1927. Preliminary press statements have been issued for 28 States.

ANNUAL CENSUS OF INSTITUTIONS

During the fiscal year the Census Bureau has continued the collection of data for the annual census of Federal and State institutions, including (1) prisons and reformatories, (2) institutions for mental patients, and (3) institutions for the feeble-minded and for epileptics. Splendid cooperation has been received from the State administrative agencies and institutions in filling out the schedules of questionnaires. Returns covering the year 1927 were received for all of the 165 State hospitals for mental disease, for the 73 institutions for feeble-minded and epileptics, and for 95 out of 100 prisons and reformatories.

Page proof of the detailed report on prisoners for 1926 has been corrected and returned to the printer.

The manuscript of the report on mental patients covering two years, 1926 and 1927, has been sent to the printer. The corresponding report for feeble-minded and epileptics for 1926 and 1927 is in preparation.

The machine tabulation of the data on prisoners for 1927 has been completed and the report is in preparation.

Preliminary summaries giving statistics by States and various census years through 1927 have been issued for each principal class of institutions covered by the census. Separate announcements on prisoners have been issued for 32 States, and on mental patients for 34 States.

RELIGIOUS BODIES

Work on the census of religious bodies has been completed, except for the handling of proof on material sent to the printer but not yet in type. The results have been published in a series of denominational bulletins, each bulletin covering either a single denomination or a group of related denominations. In all there were 96 bulletins covering 213 denominations besides a bulletin covering federated churches and 1 for independent churches. These bulletins give detailed statistics, the denominational history, doctrine, polity, and work. The statements concerning the history, doctrine, etc., were prepared by some person in a position of prominence or authority in the denomination, who was qualified to speak for the denomination on the subjects. Prior to the release the material

in page form was submitted to each denomination for approval before the data were made public. In addition to these bulletins, press releases were issued for all of the denominations, and similar releases were made for each State.

The final report for the Census of Religious Bodies will be issued in two octavo volumes. Volume I (about 500 pages) will contain a general discussion and introductory comments to the tables. The statistics in this volume will show data for the United States as a whole, the States, cities of 25,000 and over, and political subdivisions. In Volume II the denomination bulletins which have been issued will be brought together in a single volume of about 1,500 pages, which will be virtually an encyclopedia of religions in the United States. All of the textual material and tables for both volumes are now in the hands of the Government Printing Office.

CENSUS MONOGRAPHS

The census monograph on Growth of Manufactures, by Edmund E. Day and Woodlief Thomas was published last November. Two other monographs—Earnings of Factory Workers, 1896 to 1927, by Paul F. Brissenden, and Women in Gainful Occupations, by Joseph A. Hill—were completed and sent to the printer in the past year. The monograph on Ratio of Women to Children, by Warren S. Thompson, is still in manuscript.

No other monographs have been projected and probably none will be until after we have the results of the next census.

MACHINES USED IN CENSUS TABULATION

During the past year the mechanical laboratory has built 10 unit tabulating machines to be used in tabulating statistics of population in the coming census. The bureau has purchased 630 individual card punches and 400 individual card-punch verifiers and 900 schedule holders. The present electrical tabulation equipment of the bureau includes 37 card-unit tabulators, 27 card sorters, 3 card counters, 12 gang punches, and 8 adding-machine tabulators.

A number of tests of equipment have been made, and it has been ascertained that the machines to be used are superior in every way to the equipment used at prior censuses.

TABULATION WORK

In the aggregate the work performed by the tabulation division of the bureau during the fiscal year amounted to a run of 98,743,047 cards; that is, it was equivalent to passing that number of cards through one machine one time. Of course, the number of separate cards handled is less than that, since the same card may be run through the machines two or three or more times in the course of the tabulation.

The above total includes tabulations made by request for other branches of the Government or for outside agencies amounting to 10,171,210 card units. The outside agencies making the requests meet

the expense of the tabulation sometimes by depositing a sum in advance to pay for the necessary service of clerks employed by the bureau, and sometimes by appointing and paying directly the clerks to be employed on the work. The total cost of work done for either outside agencies or for other branches of the Federal Government was \$6,377.74. It includes tabulations for the Personnel Classification Board, the Treasury Department (General Supply Committee), the Milbank Memorial Fund, the University of Chicago, the Boston Department of Public Health, the Institute of Social and Religious Research, and the Virginia Agricultural Experiment Station, Department of Rural Sociology.

The great bulk of the tabulating work of the bureau the past year consisted in the tabulation of births and deaths, amounting to 73,229,158 card units. This work recurs every year, as these are annual inquiries.

As indicating roughly the approaching expansion of the tabulation work that will be necessary in connection with the decennial census, it may be stated that the tabulation of the Fourteenth Census was equivalent to approximately 2,500,000,000 card units. It will naturally be more than that in the Fifteenth Census.

OFFICE FORCE

Number of employees.—The office force at the close of June 30, 1929, comprised 709 officials, clerks, etc., 19 experts and assistants in the mechanical laboratory, and 197 temporary employees engaged on the work of the census of manufactures and the preliminary work of the Fifteenth Decennial Census, making a total of 925. The average number of persons employed in the office in Washington during the entire year was 866, as compared with 845 for the preceding year.

In addition, there were 23 temporary employees whose compensation was paid by certain social, industrial, and other organizations; and 78 employees of other departments or bureaus serving without compensation. These two classes of agents were engaged in searching the census schedules for the purpose of obtaining data which are not included in the bureau's published reports.

FIELD FORCE

The field force at the close of June 30, 1929, numbered 864 and comprised 10 consulting experts; 721 special agents employed throughout the Cotton Belt to collect data for cotton reports, showing the quantity of cotton ginned to specified dates, cotton consumed and stocks held, bale weights, etc.; and 133 special agents employed on the preliminary work of the Fifteenth Decennial Census, or on the inquiries relating to vital statistics, or on financial statistics of States and cities. In addition, there were 13 special agents at \$1 per annum, employees of chambers of commerce and other industrial organizations, and 104 employees of other departments or bureaus who were serving without compensation. During the year 380 agents were appointed for the various inquiries, 49 of

this number being enumerators of special censuses who were paid by the respective localities.

Classification.—The difficulties that have always been encountered since the passage of the classification act in properly classifying the bureau's shifting force have been increased in the past year on account of the preliminary work for the approaching census. There were 334 transfers of employees (including temporary clerks) from one main division to another during this period. New job descriptions were submitted to the Personnel Classification Board for 136 employees, 22 of these being for new appointees, 77 being reallocations of old jobs, and 37 being due to changes in work. Twenty-five appeals are still pending. The board during the past year approved 21 appeals and disapproved 43.

Very truly yours,

W. M. STEUART,
Director of the Census.

BUREAU OF FOREIGN AND DOMESTIC COMMERCE

DEPARTMENT OF COMMERCE,
BUREAU OF FOREIGN AND DOMESTIC COMMERCE,
Washington, July 1, 1929.

The honorable the SECRETARY OF COMMERCE.

DEAR MR. SECRETARY: Because of the increased speed at which present-day commerce is carried on there is call as never before for thoroughgoing, far-reaching, unbiased fact-finding studies to form a groundwork on which to build sound, yet forward-looking business policies.

The bureau has always taken the position that business should, so far as possible, conduct such research as it needs through its own organizations. Nevertheless, there are certain types of investigations that can not be initiated by private interests, that can be undertaken successfully only by an entity possessing both the confidence of the public and the prestige that goes with a governmental charter. The bureau's studies, accordingly, have in the main been confined to this latter class—those that could not well be undertaken by private agencies.

The past year has emphasized more than ever the many striking changes impending in the domestic field. One has only to note the recent developments in chain stores, in mail-order establishments, in cooperative wholesale buying, in mergers of wholesale and retail houses, in direct-to-retailer selling, and a host of like innovations to realize that our whole system of domestic distribution is in a state of flux. No one can predict what changes the next 5 or 10 years may bring; but it is clear that the most important business problems of the moment are those of marketing and distribution.

In the foreign field we have not only maintained but have most gratifyingly improved our export position. Last year, for the first time since 1920-21, shipments of American merchandise abroad exceeded five billion dollars. With a value of \$5,284,000,000 they were one-half larger than the United Kingdom's exports of British goods and three-fourths greater than Germany's domestic exports.

Our export trade affects production and employment within the country to a degree not always realized. We sell abroad about one-eighth of the total produce of our farms and about one-tenth of the goods turned out by our factories. The cutting off of our foreign commerce would not merely directly deprive of employment a great army of people but would have its repercussion in every avenue of activity and make uncertain the status of even those workers who produce solely for domestic consumption. The bureau feels that its widespread and thoroughly organized efforts for the expansion of

the export trade unquestionably have contributed to the economic stability of all who labor, for the fact that there is an export outlet makes prices better, wages higher, and employment more secure.

The demand for most agricultural products is by the very nature of things limited, and world consumption thereof can not be greatly stimulated by the activity of sellers or by anything that governments can do. The Bureau of Foreign and Domestic Commerce has nevertheless been of great aid to the American farmer in helping him market his products in competition with other exporting countries, and as to certain classes of products it has been able to aid also in developing demand abroad. It is a matter of gratification that, although our exports of foodstuffs are less than during the war period and the immediate postwar years when European agriculture was demoralized, they are greater to-day than before the World War—and that in spite of the expansion of agriculture in countries such as Canada, Australia, and Argentina.

The rapid growth of our exports of manufactured commodities is partly the result of general world progress in wealth and well-being. The demand for most manufactured commodities, unlike that for many products of the farm, is capable of almost indefinite expansion, and, besides, new manufactured articles constantly are being introduced. A great part, however, of the credit for the growth of our exports of manufactured goods may be claimed for the efficiency of American factory methods and of American salesmanship, including in the latter the activities of this bureau. During the past fiscal year our exports of finished manufactures reached the huge sum of \$2,509,000,000, being 22 per cent larger than in 1927-28 and 107 per cent larger than in 1921-22. The greatest gains during recent years have been in motor vehicles, machinery, chemicals, and other highly elaborated products.

It is true that exports constitute a smaller proportion of the output of industry in the United States than in Great Britain, Germany, and certain other countries. This is due to the fortunate circumstance that the United States, being exceptionally self-sufficient, does not need to seek abroad so large a part of what it consumes as do countries of less varied and adequate resources, and does not have to export a very great fraction of what it produces to pay for what it imports. Nevertheless, the proportion of the produce of our farms, mines, and factories which is sent abroad is important, and the absence of an export market would be no small disaster to our economic life.

This fact lends gravity to the problem facing American business in the renewed competitive ability of European industry. Great Britain has begun to rationalize, or recondition, its industries, to the end that, by replacement of plant and by enlargement of the industrial unit through regrouping or consolidation, the country may obtain the benefits of elimination of waste, standardization and simplification of practice, and other economies which attend large-scale production. With the reparation liabilities finally fixed and with the other advantages accruing under the Young plan, Germany is now free to release its revived economic powers. There is danger, too, lest by customs restrictions or the institution of more quota systems (as in the case of motion pictures) American exports will be cur-

tailed in certain markets. American commerce must be prepared to face a new situation.

Adaptation to changing conditions has always been needful in industry and trade. The signs are that more adaptation than usual will be called for in those industries that rely on foreign markets as outlets for surplus production. From now on competition in foreign trade is going to be the keenest we have had since foreign trade came to mean much to us.

The accompanying report covers the activities of the Bureau of Foreign and Domestic Commerce for the fiscal year 1928-29, during the greater part of which Dr. Julius Klein was director. From the date of his appointment as Assistant Secretary of the department to the close of the year he gave to this organization the same enthusiastic and active support that distinguished his eight years of service as director.

THE BUREAU'S DOMESTIC COMMERCE WORK

There has perhaps never been a time when business was more confused with regard to the future of existing marketing and distribution methods. The growth of the chain-store movement, the large number of mergers (often involving old-established distributing houses), the pressure of mass production for new outlets, the development of hand-to-mouth buying and of installment selling are only a few of the indications that deep-seated changes are taking place.

Under these conditions business must have some constructive assistance. The bureau's experience in the past has been that manufacturers and distributors welcome help from the Government in solving these difficult problems.

The whole field of market research is relatively new; much pioneering must still be done. For working out certain phases of the study there must be some agency in which the business public has entire confidence and which, because it has nothing to sell, can present its findings in a wholly unbiased manner. The bureau's activities of the past year have demonstrated that it can perform this function satisfactorily and at the same time supplement and reinforce what is being done by private organizations.

That business men desire the bureau to continue its activities in this field was shown by the unanimous adoption, at the annual meeting of the Chamber of Commerce of the United States last May, of a resolution reading: "Congress should provide more adequate appropriations to permit the division of domestic commerce of the Department of Commerce to undertake detailed cooperative distribution studies with those fields of industry which are interested." The moderate increase in the funds available for domestic-commerce investigations last year made it possible to expand this work in a number of directions.

REGIONAL COMMERCIAL SURVEYS

The domestic commerce division has been engaged in a series of comprehensive surveys that attempt to bring together pertinent facts regarding commercial operations in different sections of the country.

Such of this information as already exists in governmental bureaus or can be procured from outside sources is supplemented by intensive work on the ground by trained market analysts through interviews with manufacturers, merchants, bankers, farmers, and others in the territory under study. Each survey aims to bring out particulars of buying habits, consumer demand, commodity preferences, merchandising and credit practices, factors involving advertising appeal, those affecting store and plant location, and many other points.

The Commercial Survey of the Southeast, published last year as a report of some 475 pages, has met with an unusually favorable reception. The Commercial Survey of New England, second in the series, will comprise three volumes, of which The Market Data Handbook of New England has already appeared. The handbook is designed, among other things, to serve as a working manual in laying out sales territories, fixing sales quotas, routing salesmen, and determining areas which can profitably be handled from individual stores or branch houses. The other two volumes, The Industrial Structure of New England and The Commercial Structure of New England, now in press, will contain a wealth of new details on the industrial and commercial trend in that region. Manuscript for The Commercial Survey of the Pacific Southwest is nearly completed; it is based on more than 2,000 separate interviews with business men in all kinds of commercial and industrial undertakings in this rapidly growing region. Work was begun on two new surveys covering, respectively, the Gulf Southwest and the Pacific Northwest. Preliminary reports will be issued in the early months of the current fiscal year.

In addition to the formal reports on these surveys, special bulletins were issued bearing on particular phases. These were entitled "The External Trade of New England," "The Retailer and the Consumer in New England," "New England Manufactures in the Nation's Commerce," and "Transcontinental and Intercoastal Trade of the Pacific Southwest in 1926."

There also was prepared during the year the manuscript of a Market Data Handbook for the United States, which brings together in one place, by counties, information needed by the market analyst. Although this handbook will contain some material obtainable from other sources, approximately 70 per cent of the figures will be entirely new. Many of them have been secured by the tabulation of new data from the Bureau of the Census, Bureau of Mines, Bureau of Fisheries, and the Department of Agriculture, as well as through cooperation with nongovernmental organizations. Business men who have been consulted are enthusiastic over the benefits that will derive from this publication.

COST-OF-DISTRIBUTION STUDIES

A phase of the bureau's domestic-commerce work which attracted much attention during the year had to do with costs of distribution. Several studies along this line were completed and others are under way. A bulletin, entitled "The Wholesale Grocer's Problems," published in the fall of 1928, analyzed the operations of a large wholesale grocery house considered representative. Among other things, this research brought out that the firm was handling 2,100 items through

its warehouses, whereas representative chain stores serve their patrons with but 700 or 800 items; that many of the articles stocked were moving so slowly that warehouse and inventory expense absorbed all possible profit long before the goods were sold; that 45 per cent, by number, of its orders were for amounts of \$10 or less, and that no \$10 order could be handled by it at a profit. These facts have pointed the way to the elimination of many wasteful operations in our national distribution system.

Another bulletin issued during the year under the title "The Retail Grocer's Problems" presented a somewhat similar analysis of a single retail grocery store. Study of display, credit, delivery, commodity selection, and related matters revealed many wasteful practices.

These two studies furnished the basis for the bureau to undertake what has come to be widely known as the Louisville grocery survey, the most comprehensive study of distribution problems ever carried out for any group of commodities. It involved the tracing of the movement of food products through the market of Louisville, Ky., from wholesaler to consumer. The information developed while the work was in progress was so valuable as to warrant the calling of a national conference of grocery executives in that city. This conference was attended by the leaders of that industry, and at its close they expressed, as a body, their interest and confidence in the work. Since then they have, as individuals, offered the department strong support and cooperation.

The scope and plan of this survey were found to be of deep interest not only to those directly concerned in the purveying of food products but also to leaders in practically every line of industry and trade. Although the field work in Louisville was not finished until June 30, the merchants there had already taken good advantage of the facts unearthed. One store reported a 25 per cent increase in business within three months with no increase in expenses; another was able to reduce its working force and at the same time see a material increase in volume of sales. Throughout the city there is much evidence of a new spirit among the retail dealers, and stores in large numbers are adjusting their methods to meet modern standards. Because this survey represents the first practical attempt to bring manufacturers, wholesalers, and retailers to a mutual consideration of their problems, the final report will point the way to a closer cooperation between these three links in the distribution chain.

The domestic commerce division also conducted during the year studies of operating costs and merchandising methods in the wholesale dry goods, electrical jobbing, and wholesale paint-and-varnish trade. The preliminary reports issued have brought widespread and favorable comment.

Some idea of the increase in the work undertaken by this division may be had when it is recalled that during 1927-28 the operations of only 2 firms were studied in detail, whereas last year those of 9 wholesale and 27 retail houses, representing four major industries, were analyzed. The work is now somewhat beyond the experimental stage, and savings reported by the establishments in which our researches have been made denote the practical nature of the studies.

The president of one of these companies stated that his organization had been able to both decrease its gross margin and increase its net profit in the face of the most severe competition it had ever encountered. There can be little doubt that wide dissemination of the information obtained in these surveys will make for a general raising of standards in the field of distribution.

It is significant to note the acceptance of the bureau's plan in this work by the business interests involved as expressed in a resolution adopted by the national wholesale conference recently held under the auspices of the Chamber of Commerce of the United States, which is quoted in part below:

It is recommended that unit cost studies be encouraged which will discover the entailments of each unit operation large enough or important enough seriously to affect operating results, to the end that causes of inefficiency may be uncovered and correctives may be suggested which will reduce or eliminate losses.

Whereas there is no body which can initiate, organize, and carry through widespread cost investigation, commanding unanimous support because of its thoroughness, impartiality, and responsibility, which is essential to the general acceptance of its findings: Therefore,

It is recommended that the Department of Commerce be asked to inaugurate a movement to establish a central control of cost studies, organized, directed, and supervised by the department, to which trade associations and other groups may appeal to initiate and conduct such inquiries as may be desired by them, in order that the results may be published in such form and with such dispatch as would foster the extension of this type of inquiry and promote the introduction of methods adapted to meet the pressing need for distributive economy.

INDUSTRIAL MARKET STUDIES

During the year the domestic commerce division completed a report on the gray-iron foundry industry which, although as yet issued only in preliminary form, has had a far-reaching effect upon this industry and has been responsible, in a measure, for putting it on a better economic basis. Other studies now under way or arranged for include surveys of leather-glove distribution, in cooperation with the National Association of Leather Glove and Mitten Manufacturers; the distribution of pumps and water systems, in cooperation with that industry; the blue-print and allied industries; knitting machines in the knitted-outerwear industry in the vicinity of Philadelphia; and lathes in use in the wood-turning industry.

The two latter studies are concerned with an investigation of industrial equipment which has been urged upon the bureau by leaders in various fields. It is believed by many that the present overcapacity in certain industries is closely tied up with the widespread use of out-dated equipment, which raises the cost of production. A fact-finding survey showing the relative efficiency of the actual equipment of individual plants in an industry would, it is thought, throw much light on this subject.

RETAIL-CREDIT STUDIES

Conjointly with the National Retail Credit Association the bureau is conducting a nation-wide credit survey that will embrace all important lines of retail trade. Over 1,000 credit bureaus and 300 chambers of commerce are cooperating in this work. More than 200,000 questionnaires were mailed, and a large proportion of these have already been filled out and returned. A preliminary report has

been issued, covering three lines of retail trade and presenting statistics from stores with combined sales of over one and a half billion dollars. It is expected that the final report will be available about the middle of the current fiscal year. The chief executive of the largest retail-credit association states that the results which are being secured will be of great importance in stabilizing business and will likely induce many benefits contributing toward lower living costs for the consumer and a better balance for the tradesman.

Credit conditions in the grocery stores of Louisville, Ky., were studied as part of the grocery survey already alluded to. Detailed information secured from 416 grocery stores was analyzed and published under the title "Credit Extension and Business Failures." A still more comprehensive investigation of credit extension and bankruptcy in grocery stores is now being carried out in Philadelphia, and plans have been perfected for a somewhat similar research in the restaurant business in Kansas City, Mo.

THE HANDLING OF SPECIAL INQUIRIES

The bureau has found a need to exist for some agency to correlate and furnish to business men information bearing upon special problems. A large amount of data is available in the various governmental departments and organizations, but the average business man does not know where to go to procure it. The bureau is therefore attempting to act as a clearing house for such information from both governmental and nongovernmental sources, and has set up in the domestic commerce division a special section to which inquiries coming to the bureau are sent after first being routed through the appropriate commodity division for technical treatment. The special-inquiries section endeavors to coordinate the results of governmental research which can be applied to business, to analyze available material from all authoritative sources, and to put the inquirer in touch with experts in the Government service or with sources of information on the outside which bear upon the problem submitted. Each year since 1923 has seen a remarkable growth in the demand for this type of service—last year, an increase of 73 per cent in the number of inquiries handled, but there is no measure for the increase in scope of the problems considered nor for the savings in dollars and cents accruing from their solution. The bureau is attempting to equip its 29 district offices to handle a large proportion of inquiries of this class.

PUBLICATIONS AND PUBLICITY

Research is of little service to the public until brought to the attention of those who can make use of its findings. During the year just closed a special effort was made to acquaint business men with the domestic-commerce work of the bureau through press releases, feature articles, and public addresses. The division's weekly multi-graphed bulletin, issued under the title "Domestic Commerce," which now goes to a mailing list of 15,000, contained 1,210 items relating either to the work in the bureau or to other significant developments in the field of marketing and distribution. Fourteen new publications were released by the division and approximately 385,000 copies

thereof distributed. A mailing list is maintained of those who desire notice of new domestic-commerce publications, and this list now contains nearly 28,000 names.

One measure of the interest in the bureau's domestic-commerce work is the space devoted to it in business magazines and newspapers. A check up of such clippings and of such publications as come to the bureau gave a total of 15,000 column inches for last year, two-thirds of which were magazine items. More than 100 public addresses were made by members of the domestic-commerce staff before trade associations and other business organizations.

The district offices of the bureau have been of immeasurable assistance in bringing this domestic-commerce work to the attention of business executives in their territories. It is hoped that provision will be made in the near future whereby marketing specialists can be placed in these offices, which would have the effect of multiplying many times the effectiveness of the domestic-commerce work now being done.

MISCELLANEOUS ACTIVITIES IN THE DOMESTIC FIELD

The bureau carried on many other activities in the domestic field. In the domestic commerce division two other important publications were issued—Market Research Agencies, which attempts annually to bring together a list of all studies on market research available to investigators, and Commercial and Industrial Organizations of the United States, a directory of trade associations and other business organizations, both national and local in scope. Several of the commodity divisions made domestic-marketing studies, among them being surveys of the confectionery industry by the foodstuffs division, of radio sales by the electrical equipment division (which is undertaking a similar study on electrical refrigeration), and of tire sales by the rubber division. The textile division is conducting research on new uses of cotton, the transportation division on inland water conveyance, and other divisions are cooperating in one way or another in the domestic-commerce program.

During the year a study of prison industries and prison-made goods was completed by the bureau under the direction of a committee appointed by the Secretary of Commerce at the request of business and civic organizations.

DOLLARS-AND-CENTS RETURNS TO THE BUSINESS PUBLIC

Highly satisfactory growth continues to be shown in the dollars-and-cents returns obtained for American business firms through the bureau's trade-promotive work—a statement borne out not only by the substantial sums involved but by the wide diversity of achievements reported.

Aid in the selection of suitable foreign connections (one of the most helpful contributions the bureau has made to the expansion of American export trade) produced to a large extent the results on which a money value could be placed. However, only a part of the actual benefits each year becomes known, for the bureau is not informed of all instances in which business or savings accrued from its efforts. Many of the services rendered, such as preventing American firms from dealing with unreliable and incompetent importers

or from expending time and money to introduce articles that could not be marketed in the particular area chosen and counsel given preparatory to offering goods in foreign countries, though of major importance, are not computable in dollars and cents. The few examples below illustrate the character of the bureau's efforts in behalf of the American exporting community.

Airplanes.—Acknowledging assistance given by the Santiago office in doing business with Chile a New York airplane manufacturer wrote: "We encountered very strong and extremely well-organized competition in Chile. The work of the commercial attaché at Santiago was of the utmost help to us in closing a contract covering about \$750,000 worth of airplanes and equipment."

Aluminum ware.—The bureau's Winnipeg office interested a Canadian manufacturer's representative in aluminum ware made in Wisconsin. During the six remaining months of the year he placed orders for \$100,000 worth of these utensils.

Automobiles.—The automobile industry affords one of the outstanding examples of the way in which the bureau has been able, over a course of years, to render effective service to a successful export industry. The Rio de Janeiro office pointed out to a New York export company last year that, owing to the inability of its only Brazilian agent to cover the whole country, the car which it was marketing was practically unknown in that city. The importer suggested by this office was appointed distributor for Rio and vicinity, contracting for \$225,000 worth of cars.

A Turkish importer wrote: "You may be interested in knowing that the first idea of our firm's engaging in the automotive business with America originated with your commercial attaché at Constantinople, who enlightened us fully about the possibilities. This idea resulted in our importing about \$300,000 worth of cars the first year, \$500,000 worth last year, and we have very good hopes of more than doubling the last figure during the present year."

An Ohio automobile manufacturer reports that after five years of hard work in South Africa he still was without a distributor, and when finally one was obtained this was solely through the efforts of the trade commissioner at Johannesburg. The connection has already meant \$60,000 worth of business, although arranged but a short time ago.

When the Chilean distributor of a car made in New Jersey relinquished his agency, the commercial attaché in Santiago undertook to interest other firms, with the result that a new agency was established which has taken \$228,000 worth of these cars.

An Indiana manufacturer whose agency in the Netherland East Indies had been placed with a firm lacking sufficient capital was enabled to dispose of \$30,000 worth of warehoused cars through the assistance of the Batavia office and to establish a satisfactory new connection, the initial order amounting to \$12,000.

The representative of a New York automobile firm after spending several weeks in Panama and Colombia in unsuccessful efforts was enabled to obtain effective advertising for his car through a method suggested by the commercial attaché at Panama City, resulting in \$15,000 worth of immediate sales, with prospects good for placing an agency.

Collaboration by the trade commissioner at Tokyo is credited by the traveling representative of an Ohio automobile company for his success in finding a satisfactory distributor in Japan. A 15-month contract, calling for \$250,000 worth of cars, was signed.

A Michigan manufacturer of motor cars, after stating that assistance given by the Detroit office and foreign representatives of the bureau made it possible for his company to do a three-and-a-half million dollar business with 15 foreign countries, goes on to say: "It would have cost us \$75,000 to have sent representatives directly to these countries to make contact with these firms."

Assistance by the Lima office to Peruvian importers seeking a solution for financing problems connected with bonded warehousing and other difficulties has greatly facilitated the importation of American automobiles into Peru.

Automobile accessories.—An Australian merchant has imported \$300,000 worth of automobile accessories from 19 American firms whose names were supplied by the Sydney office; and an Iowa manufacturer has sold \$30,000 worth of motor trunks to a Canadian distributor selected with the aid of the Winnipeg office.

Baking equipment.—Among the many American products enjoying large sales in New Zealand through connections formed with the assistance of the Wellington office are baking ovens manufactured by a Pennsylvania concern whose orders from this source amount to \$75,000.

Through the Toronto office a New York manufacturer of doughnut machinery learned of the opportunity to sell \$150,000 worth of this equipment to a Canadian firm which states that it will place more business.

Brass goods.—California and Ohio manufacturers have sold \$60,000 worth of brass goods to Australian connections suggested by the trade commissioners stationed in that Commonwealth.

Builders' supplies.—The Toronto office helped Pennsylvania, Michigan, and Connecticut makers of heating and other building equipment of a mechanical nature to obtain \$350,000 worth of Canadian business. For a Missouri manufacturer of architectural steel the Ottawa office found a Dominion purchaser whose orders approximated \$50,000. After having given up this market an Ohio firm making sheet-metal building specialties was referred by the bureau's Vancouver office to an agent who placed a \$20,000 order.

Canning machinery.—Exports of canning, case-packing, and labeling machinery by New York, Maryland, Illinois, and California firms to contacts in Germany established through the Berlin office amounted last year to \$91,000.

Chemicals.—A New York chemical exporter was assisted in concluding a contract in Germany involving shipments in excess of \$3,000,000. This contract necessitated the purchase of additional plant equipment on the part of the producer and provided employment for a largely increased working force.

Coal.—As a result of assistance by the Toronto office, \$10,000 worth of coal has been sent from New York and Pennsylvania to a Canadian firm which states that prospects for much more business are excellent.

Dairy equipment.—Some \$120,000 worth of milk-handling equipment was sold by an Illinois manufacturer to a Brazilian with whom he was put in touch by the Sao Paulo office.

Drills.—The trade commissioner at Calcutta made it possible for an American manufacturer of drills to obtain orders amounting to \$60,000 from the Indian Government.

Electrical equipment.—After obtaining a \$588,000 French contract for electrical equipment through the collaboration of the Paris office a New York exporter wrote: "Had you not been able to assist me in this matter the order would have gone to a European competitor."

Flour-mill machinery.—An Illinois builder of flour and cereal mill machinery made 45 new foreign connections as a result of trade leads supplied by the Chicago office, booking \$125,000 worth of business with Europe and Mexico.

Foodstuffs.—Six shippers of fruit and canned foods in California, Washington, and New York have done a business exceeding \$400,000 with German connections made through the Hamburg office; while the bureau's London office aided in the selection of agencies that have meant \$400,000 additional business in Great Britain for exporters of fruit juice, fruit, rice, and canned foods in Illinois, Florida, California, Virginia, Louisiana, and New York.

A Washington flour mill reports effecting a "considerable" saving and \$200,000 worth of business, principally with China, through Seattle office aid.

A Philippine connection, which has meant \$500,000 worth of additional business to a California exporter of general groceries, was obtained through the bureau's San Francisco office; and a California exporter of citrus fruits concluded, with the assistance of the Los Angeles office, trade connections in Scandinavia and China from which business to the extent of \$852,000 has been realized.

Fountain pens.—When the Austrian agent of a New York maker of fountain pens went into the hands of a receiver, the interests of this firm were protected through prompt action by the bureau's Vienna office, and another agent secured whose sales during the past year amounted to \$10,000.

Glassware.—The attention of a Panama importer, whose yearly requirements approximate \$30,000, was directed by the commercial attaché to a California line of glassware, for which he later took over the agency.

Hardware.—The Sydney office assisted 22 American manufacturers of hardware in disposing of \$145,000 worth of their products on the Australian market.

Heaters.—Forty thousand dollars' worth of oil heaters manufactured in Maryland was sold through a Canadian distributor who took over this line at the suggestion of the Toronto office.

Hospital equipment.—Aid by the Bucharest office enabled an Illinois manufacturer to sell \$80,000 worth of X-ray equipment to Rumania; while through the assistance of the Cairo office a New York manufacturer's representative booked orders for \$18,000 worth of hospital equipment in Egypt.

Leather.—The Swedish agent of a New York exporter, secured through the help of the commercial attaché at Stockholm, took \$300,000 worth of this firm's leather last year; another New York firm shared with a Massachusetts exporter \$83,000 worth of leather business in China resulting from a radio message from the bureau's office in Shanghai; and a New Jersey company has sold \$75,000 worth of leather through a Belgian agency suggested by the Brussels office.

Leather manufactures.—Assistance by the Ottawa and Montreal offices to a New York manufacturer of footwear specialties resulted in a substantial expansion of this firm's sales in Canada. In two weeks' time the purchases of one customer alone exceeded \$25,000—equivalent to the manufacturer's total sales in the entire Dominion during the preceding year.

With a connection obtained through the bureau's office at Bogota the traveling representative of a Missouri firm transacted \$50,000 worth of shoe business in Colombia in two months.

Lighting plants.—A Canadian firm to which the Winnipeg office pointed out the profitable business that could be worked up in farm-lighting sets made agency connections with an Indiana manufacturer that have brought the latter \$10,000 in orders so far.

Lumber.—Survey of the market by the Hamburg office revealed a good demand in Germany for the products of a Washington lumber company but little business being done through reluctance of the agent then handling the line to push it properly. Recommendations by the trade commissioner resulted in the making of a new connection that has done \$300,600 worth of business in a short time.

Two Panama firms which began experimenting with American redwood and Douglas fir at the suggestion of the commercial attaché have taken \$110,000 worth of this lumber from Washington and California.

A Tennessee lumber company states that the bureau's office at Memphis assisted it in finding 19 foreign representatives who have placed approximately \$205,000 worth of orders for hardwood flooring.

Lumbering machinery.—The Tokyo office has endeavored to introduce new appliances and processes into Japan which would bring about the mechanizing of Japanese forestry operations. As a result, the Japanese Government is planning to use American gasoline skidders extensively, having already ordered \$18,000 worth of this equipment.

Meat products.—An Illinois packing house whose business in Venezuela had "fallen to practically nothing" obtained, with Caracas-office collaboration, a new agent who placed \$89,000 worth of orders for meat products in a year's time.

Shipments of meat products of another Illinois firm, valued at over \$1,000,000, were denied entry into a European country except at a prohibitive duty. Following explanations by the commercial attaché a lower duty was applied, which, the exporter states, brought about a saving of \$30,000.

Motor cycles.—A manufacturer of motor cycles has obtained \$60,000 worth of business in Egypt, Poland, and Brazil from connec-

tions made with the help of bureau offices in Cairo, Warsaw, and Sao Paulo.

Office supplies.—Agencies placed with the aid of bureau representatives have made outlets in Sweden for \$50,000 worth of accounting machines from New York; in Finland, Brazil, and Turkey, for \$50,000 worth of typewriters from Illinois and New York; in Egypt, Newfoundland, and the Straits Settlements, for \$27,000 worth of dictaphones from New York; and in Czechoslovakia, for \$23,000 worth of adding machines from New York.

Oil-well machinery.—Information furnished by the Buenos Aires office enabled a firm in California to obtain a \$250,000 Argentine order for oil-well machinery.

Paints.—Two California manufacturers of paints and varnishes transacted \$28,000 worth of business the first three months with Philippine connections made through the bureau's Manila office. A Netherland order for \$20,000 worth of white lead went to an Illinois firm through the instrumentality of the bureau office at The Hague.

In a Latin American country the paints and roofing specialties of a New York manufacturer were barred on account of trade-mark difficulties which were removed through the commercial attaché's friendly endeavors, resulting in \$300,000 worth of business.

Paper and paper goods.—A representative of a New York export house, upon arrival in Johannesburg, was assisted by the trade commissioner in locating distributors for his various lines in South Africa. Among the connections formed was one for paper cups which brought orders amounting to \$35,000 in a short time.

A California firm whose name was referred to a Porto Rican importer by the trade commissioner at San Juan did \$100,000 worth of business in wrapping paper; and the Wellington office assisted two New York paper companies in obtaining orders totaling \$16,000 from New Zealand.

Petroleum products.—Advice from the Paris office resulted in the placing of an agency in France and the booking of orders for \$200,000 worth of American lubricating oils.

Plumbing equipment.—Sales suggestions from the Sao Paulo office to a New York manufacturer of plumbing equipment brought the latter \$100,000 worth of business in Brazil; and from the Lima office, \$15,000 worth in Peru.

Printers' supplies.—The following transactions were attributed to assistance given by bureau field representatives: A \$50,000 order for bookbinding machinery, which went from New York to Hungary; one for \$50,000 worth of linotypes, from another New York firm to Finland; orders for \$15,000 worth of printing ink, sent by two Ohio firms to Brazil; and \$10,000 worth of miscellaneous printing equipment, purchased from American manufacturers by a newspaper in Panama City.

Public-works contracts.—A New York firm of contractors assured the commercial attaché in Santiago that his advice and his acquaintance with the local situation were important factors in concluding contracts for the construction of two dams in Chile involving a

total of more than \$1,750,000. Assistance rendered by the commercial attaché at Buenos Aires was instrumental in the closing, by a Massachusetts firm, of a \$1,700,000 paving contract in a South American city.

A South American office also reports the letting to a New York firm of a \$500,000 contract for the installation of a conveyor system for a municipal building. Not only was the opportunity to bid on this project originally brought to this firm's attention by the bureau's office, but a postponement of bidding was obtained that enabled the New York engineer to reach the country in time to submit his offer.

Pumps.—A Missouri manufacturer of deep-well centrifugal pumps was assisted by the commercial attaché in forming a connection in Mexico that brought in an initial order of \$12,500.

Radio sets.—Through an agency arranged with the aid of the Toronto office a New York manufacturer disposed of \$200,000 worth of radio sets and accessories in Canada during the past year, with a great deal of additional business in sight.

Refrigerators.—The Bucharest office assisted in the placing of agencies for Michigan and Ohio manufacturers of electric refrigerators, resulting in \$74,000 worth of orders in Rumania; the efforts of the Rio de Janeiro office enabled the representative of an Indiana refrigerator company to obtain a \$60,000 Brazilian contract; and advice from the Bombay office led to the selection of an agent for a Michigan corporation which sold \$15,000 worth of units in India.

Road-making machinery.—The Spanish representative of a Wisconsin manufacturer of concrete mixers, cranes, and power shovels, who obtained his appointment with the assistance of the Madrid office, reports that during the past year he sold products of this firm to the amount of \$350,000; while the purchases of the Brazilian agent of this firm, obtained through the cooperation of the bureau's office in Sao Paulo, amount to \$25,000.

An American manufacturer of gasoline-driven shovels who had consigned a \$14,000 order to a Brazilian bankrupt firm was saved from loss by the commercial attaché at Rio de Janeiro, who was instrumental in having the shipment taken over and later disposed of at invoice price.

Recommendations made by the Montevideo office brought about the purchase of \$125,000 worth of road machinery from three American firms for use in Uruguay.

Rubber sundries.—New York and Ohio manufacturers of miscellaneous rubber goods have done \$198,000 worth of business in Sweden, Austria, and Egypt through connections made with the help of the Stockholm, Vienna, and Cairo offices of the bureau.

Salt.—A firm in British Columbia importing salt from across the ocean was furnished the name of a California supplier by the Vancouver office and \$110,000 in orders resulted.

Sewer pipe.—At the suggestion of the Montreal office an Ohio manufacturer of sewer pipe furnished quotations to a Canadian firm of engineers and obtained a \$25,000 contract, with prospects of at least \$75,000 worth of this pipe being sold in the next 12 months.

Smoke consumers.—Through the efforts of the Budapest office a Delaware manufacturer of smoke consumers received an \$80,000 order from a Hungarian railroad company.

Soap.—Soap works in California, Florida, and Texas obtained representation in Porto Rico with the aid of the trade commissioner at San Juan and sold \$105,000 worth of laundry soap in seven months.

Soda fountains.—Germany bought \$80,000 worth of soda fountains from a New York manufacturer through an agent suggested by the Berlin office; and \$35,000 worth of equipment of this sort was shipped from Ohio to a Brazilian connection suggested by the Sao Paulo office.

Steel.—Ohio alloy steel to the value of \$30,000 went to a Brazilian firm whose name was furnished by the trade commissioner at Sao Paulo.

Sugar-mill machinery.—A New York manufacturer has sold over \$35,000 worth of sugar-mill machinery in Brazil to a buyer with whom he was put in touch by the Rio de Janeiro office.

Textiles.—By arranging agencies for two well-known manufacturers of bathing suits the Berlin office made it possible for these firms to expand their exports to Germany by \$170,000 last year; and similar service on the part of the Montreal office enabled three New York textile houses to obtain \$90,000 worth of additional business in Canada.

The Toronto office referred a Canadian manufacturers' agent to Pennsylvania and New York mills producing cotton goods; business to the extent of \$100,000 already has been concluded, with favorable future prospects.

A trial order for cotton duck placed by an importer in the Straits Settlements at the suggestion of the Singapore office led to \$85,000 worth of business with a New York house in 10 months' time; and the success of six New York mills in selling \$90,000 worth of piece goods in Malaysia was due to the efforts of the bureau personnel in Singapore and Batavia.

Market possibilities for Turkish toweling in Chile were called to a Georgia manufacturer's attention by the Santiago office. The agency subsequently established purchased \$25,000 worth of this commodity.

Assistance by the Cairo and Alexandria offices to seven New York manufacturers' representatives led to \$190,000 worth of Egyptian business, principally in knitted and piece goods; while the Bombay and Calcutta offices were credited with having assisted four New York textile houses in obtaining \$105,000 worth of export trade in the highly competitive market of India.

Theater seats.—The bureau's office in Singapore supplied to a New York manufacturer of theater seats information that enabled him to obtain a \$15,000 order for the Straits Settlements.

Theatrical goods.—A New York manufacturer of theatrical goods declared: "Due to cooperation received from your organization, the increase in our sales during the year amounted to \$110,000. Moreover, had we sent our own salesman to make the contacts and secure this business, it would have cost us certainly at least \$6,000."

Thermometers.—A Massachusetts maker of thermometers, controllers, and gauges has sold \$250,000 worth of his products to Europe and Latin America as the result of assistance rendered by the Boston office.

Tires.—Two New York manufacturers sold \$220,000 worth of tires in Finland, Spain, and Egypt through agencies arranged with the aid of bureau offices in Helsingfors, Madrid, and Alexandria; and sales of \$185,000 worth of tires to Austria, Rumania, and Spain by five Ohio firms resulted from connections fostered by the Vienna, Bucharest, and Barcelona offices.

Tools.—An Ohio maker of tools found sales in a near-by market impractical because of the high duty levied on his product. Upon explanation by the commercial attaché a lower rate was applied, concerning which the manufacturer wrote: "We frankly believe we are justified in saying that this duty reduction will mean an increase of at least 100 per cent in this year's sales alone. It has made it possible for us to do a business of \$5,000 to \$6,000 per month."

Vacuum cleaners.—A New York manufacturer has furnished \$45,000 worth of vacuum cleaners to an importer in the Netherlands whose desire to purchase was communicated to American firms through the office at The Hague.

Wallboard.—The export-trade investigator of an Illinois wallboard manufacturer states that his six years of travel in locating overseas markets has brought him into touch with bureau offices throughout the world. As a recent example of the progress he is making in opening up new outlets with the help of bureau representatives he cites assistance given by the Calcutta office that led to agency arrangements and \$70,250 worth of immediate business in India. Among other connections definitely traceable to bureau co-operation he mentioned one in Denmark, which has done a business running close to \$1,000,000; and one in Rome, which has contracted to dispose of \$400,000 worth of his firm's wallboard in five years.

Woodworking machinery.—The factory representative of a New York manufacturer of woodworking machinery obtained introductions through the Prague office that made it possible to place \$20,000 worth of business in Czechoslovakia.

Miscellaneous.—An Australian importer writes the bureau's office at Sydney: "Through your service we have been fortunate enough to secure several very valuable agencies with whom our business during the year amounted to \$520,000." These agency arrangements covered New Jersey steel flooring; Illinois railway appliances; Michigan trailers; and New York vacuum cleaning machinery, valves, and exhausters.

Australian business men have been encouraged by the Melbourne office to visit the United States when traveling, and letters of introduction have been furnished them with a view to facilitating the making of desired American connections. During the year such service resulted in 16 American firms obtaining representation in Melbourne, with initial orders totaling \$44,000. These firms included radio, electrical-goods, vending-machine, and grinding-tool manufacturers of Illinois, an Ohio maker of wireless sets, textile mills of New York and Massachusetts, and a Michigan manufacturer of electrical refrigerators.

AID FOR FIRMS IN ALL PARTS OF THE UNITED STATES

In all of its trade-promotion work the bureau functions as a whole to the end that American commerce may best be served. Thus, while the foreign office in the areas named should perhaps be credited with initiating the transactions listed below, every element of the bureau organization contributed to their successful culmination, and, as is seen, practically every State in the Union profited.

Alabama products marketed with the assistance of the bureau last year included shipments of fresh vegetables to Canada, of naval stores to Denmark and Japan, and of lumber to Belgium, Germany, Spain, and the Netherlands. *Arkansas* exporters utilized the bureau's facilities in introducing their tents and awnings into Mexico and Cuba, pine lumber into the United Kingdom, and cucumbers into Canada.

New buyers for *California* products have been found throughout the world with the help of this bureau; last year grapes were disposed of in the Orient and South America, edible nuts in Australia, Sumatra, and Great Britain, olives in Canada, canned butter in Mexico and South and Central America, irrigation appliances in South America, canning and fruit-drying machinery in Mexico, Italy, France, and Africa, asphalt roofing in China and Peru, and jewelry in the Philippine Islands. From *Colorado* many carloads of beans have been sold in Porto Rico. *Connecticut* engineers' supplies and geometric tools were shipped to Canada, garage equipment to Spain, outboard motors to British Malaya, vacuum bottles to Cuba, metal hose to Mexico, and ball bearings to Egypt.

Sales of *Delaware* bottling machinery were effected in India, South America, and Mexico, and of confectionery in Egypt.

Florida exporters were aided in selling grapefruit in Canada, Australia, and England, sponges in Argentina and Europe, paving blocks in Porto Rico, dry kilns in Canada, and lumber in Latin America.

Georgia mills sent cotton and worsted goods to Germany and the Netherlands and cotton waste to England, the furniture factories of the State found new customers in Porto Rico, and its forests supplied rosin and turpentine to South America and pecans to Canada.

Illinois manufacturers availed themselves of the services of the bureau in selling, among other articles, dental supplies and carpets to France, steel furniture and dehydrated vegetables to Canada, farm engines to Latvia, fountain pens and chemicals to Singapore, adding machines to Cuba, and hosiery to Panama. *Indiana* vacuum cleaners and enameled ware found new outlets in Canada, playground equipment in Switzerland and Hawaii, furniture in Porto Rico and Argentina, engines in Bulgaria, Italy, and Colombia, and oil burners in Australia. From *Iowa* oak lumber was sold in Canada, well-drilling machinery in India, China, England, Australia, and South Africa, cereals in Finland, anchors in Uruguay, incubators in South America, Rumania, Cuba, and Spain, and washing machines in New Zealand and Australia, while a large quantity of flavoring extracts went to a Manila ice-cream plant.

From the State of *Kansas* airplanes were shipped to Australia and China, wheat-testing equipment to Canada, and flour to South America. *Kentucky* tobacco is being marketed in Turkey, Central

America, Straits Settlements, and Haiti, hardwood lumber in the United Kingdom, hosiery in Cuba and Canada, and asphalt in the Straits Settlements.

Louisiana producers have opened up, with bureau aid, new markets in Europe and South America for rice, in Central and South America for sash and doors, in the British West Indies for boxes, and in Central America and Porto Rico for paper.

A *Maine* manufacturer of hoists and cranes has done a large business in Newfoundland, and quarry tools and forgers from this State have been sold in Canada. New Zealand purchased an enameling plant in *Maryland*. Germany took hosiery from this State, and an agent was found in Mexico for a *Maryland* manufacturer of flooring. *Massachusetts* laboratory apparatus went to Spain, textiles to Brazil, tennis rackets to Hungary, leather goods to Central America, the West Indies, and the Near East, lumber to the United Kingdom, South Africa, and the Netherlands, plastic paints to Australia, England, Japan, and Cuba, and bedroom furniture to Venezuela.

Michigan motor boats were placed with satisfactory distributors in England, Germany, Sweden, and Egypt, blue-printing machinery in Denmark, concrete machinery in Costa Rica and the Straits Settlements, electric toasters in Australia and Africa, and masons' tools in France, South Africa, Argentina, England, and India. *Minnesota* was assisted in disposing of chemical products in South America, Australia, and Mexico, dentists' supplies and equipment in Australia, Sweden, Poland, and New Zealand, campers' equipment in England, Mexico, and Australia, flour in Denmark, Cuba, and South Africa, and farm machinery in Rumania, Hungary, Italy, Germany, and Poland. *Mississippi* radio sets are selling in Canada through an agency established with the bureau's assistance. *Missouri* airplanes and accessories have found a market in Mexico and Brazil, lumber in Germany, China, Chile, and Argentina, flour and petroleum in Guatemala, batteries in Belgium, France, Italy, Spain, and India, and confectionery in South America and the Philippine Islands, and a buyer was obtained in Egypt for a shipment of *Missouri* automobile accessories after the original consignee had refused to accept it.

The bureau helped a *Nebraska* manufacturer of gasoline engines to select a distributor in Canada; and a *New Hampshire* manufacturer of sporting goods was furnished information that led to trade connections and substantial sales in Mexico, South America, Jamaica, and the Orient. From *New Jersey* school furniture and office supplies were sent to Singapore, electric refrigerators and machinery to China, radiators to Finland, drapery fabrics to Canada, and radios to Japan; and a *New Mexico* exporter of alfalfa meal found new buyers in Denmark and England last year.

Among the divers products which *New York* exporters have disposed of in overseas markets through bureau cooperation are film projecting machines in Sweden, soda fountains in Panama, check projectors in Chile, electric dish-washing machines and radios in Switzerland, iron and steel ware in Europe and Japan, millinery in Porto Rico, and knitting machinery in England. *North Carolina* exporters were assisted in marketing cotton and knitted goods in Spain, England, Brazil, and India, leather belting in England, and

leaf tobacco in Europe and Egypt, and a firm in this State was kept informed last year on matters relating to the Brazilian coffee industry. Carloads of potatoes from *North Dakota* were shipped to Canada.

Ohio manufacturers availed themselves of the services of the bureau in selling hardware and toys in the Far East, radios in Australia, roofing cement and oil paints in Greece, tires in Hungary, hosiery in Denmark, and rubber novelties in Finland. *Oklahoma* flour was sold in Brazil and Porto Rico; and agencies were established in France for *Oregon* pine doors, and in South America for bathing suits manufactured in this State.

Pennsylvania, through the bureau's efforts, furnished stainless steel plates to Canada, engineering supplies to South Africa, Australia, Spain, and Brazil, plate glass to the Philippine Islands, India, Australia, Uruguay, and Argentina, cut glass to Europe and the Philippine Islands, mirrors to India and Central America, candy machinery to the Far East, and compressors to Switzerland and Canada, and a manufacturer of paper cups was aided in overcoming a difficult problem in connection with the marking of his product in Canada.

Rhode Island rubber and canvas footwear found a market in the Philippine Islands, radio specialties in South America, electric refrigerators in the Straits Settlements, battery cables in Greece, and textiles in Canada.

Lumber from a *South Carolina* mill was sold in Germany.

Tennessee manufacturers established agencies in Canada for yarn, in Uruguay and Argentina for pumps, in the Far East for paints and varnishes, and in Cuba, Mexico, and Venezuela for hosiery. *Texas* exported ready-cut and portable houses to Rumania, grain and seed separators to France, Italy, and Australia, tents, awnings, and folding cots to Colombia and Porto Rico, bank fixtures and safes to Mexico, scrap rubber to Great Britain, Germany, France, and Japan, rice to a number of European countries, and large quantities of yellow pine to Porto Rico.

Utah sent a large amount of honey to Germany, and a manufacturer of radio products in this State was assisted in obtaining representation in Argentina.

A *Vermont* manufacturer of embossing machinery is doing business with a connection established through bureau cooperation in Finland. *Virginia* jute products and peanuts were shipped to Canada, peanut cleaning and grading machinery to South Africa, dental supplies to Czechoslovakia, trunks and traveling bags to the Netherland West Indies and Panama, washing machines to New Zealand, and electrical medical apparatus to China.

From the State of *Washington* lumber products and apples went to France, soda fountains to Japan, and builders' hardware to Panama. A *West Virginia* manufacturer of steel rails was assisted in finding a buyer in South America, and a firm making art glass sent its wares to new customers in Canada. Among other assistance to *Wisconsin* manufacturers the bureau helped to market vulcanizers in Turkey, concrete mixers in Malaysia, motor boats and hosiery in Egypt, knitted goods in Australia and South Africa, and cooking utensils in Central and South America, Egypt, and Czechoslovakia.

AVENUES FOR EXPANSION OPEN TO THE BUREAU

"Facts" are the keys which unlock many doors of opportunity—opportunity not only to profit, but to serve. Indeed, in their gathering the bureau can render its finest service to commerce.

Costs of distribution have been rising in recent years and in considerable measure have offset the savings accruing from lowered production costs. There is urgent need for attacking this problem from a new angle—for developing methods by which the distributor may know what it costs him to handle individual commodities, to serve individual customers, and to perform individual operations. Data of this character on production costs have been credited with many significant savings in manufacture, and it is believed that similar results can be obtained in distribution. As indicated in the discussion of our domestic-commerce activities, commendable progress was made last year. The interest which business men have evinced and the need for constructive leadership in this field over the next few years would seem to justify a material strengthening of this work.

The bureau has 29 district offices located in important commercial centers and will open 2 more this year under the authority of Congress. These offices have been established primarily to serve exporters in their respective territories. With the further development of the bureau's domestic-commerce work it is daily becoming more evident that our district offices could render invaluable service to local manufacturers and merchants by furnishing them information already available in the various Government departments, by bringing to their attention the results of both private and governmental research, and by assisting them to solve some of the problems which they face. The present district-office personnel is not much more than sufficient to serve those clients engaged in foreign trade. By strengthening the staffs it would be possible to add a domestic-commerce service that would be greatly appreciated by thousands of business men in each of these districts.

Since the organization of the commodity divisions the bureau has been able to render highly valuable services to manufacturers of articles used in construction work, but none of the existing divisions has been in position to cooperate effectively with American contractors interested in construction projects in foreign countries. This is particularly unfortunate inasmuch as the execution of an important contract by an American crew is recognized as an admirable way to promote American trade; for after the work is completed the local population will be found to be regular users of a broad line of American commodities, from breakfast foods and cameras to motor cars and clothing, and the business community and Government departments frequently will have developed an interest in American construction methods, materials, and machinery. American capital is flowing into foreign countries at a very rapid rate, American contracting firms are in charge of projects involving millions of dollars all over the world, and the need for a more perfect bureau service along these lines is not only obvious but acute.

Inclusion of all sections of the country and all navigation systems would seem a desirable extension of the somewhat circumscribed sur-

vey of the inland waterways of the United States now in progress. The enlarged program should analyze the merits of the development of inland waterways and canals from the point of view of (a) their economic importance, (b) their justification, based upon cost and other relevant data, and (c) their relationship to other forms of transportation (rail, motor truck, and ocean), and could, at the same time, review the motor-truck transportation field. Opportunity to assist in the solution of these domestic distribution problems is open to the bureau through cooperation with the shippers' regional advisory boards.

The bureau began last year a study of industrial traffic management, the purpose of which is to show the status of industrial traffic functions in American business, the relation between the traffic and other departments of well-coordinated establishments, and how transportation waste may be eliminated by the proper functioning of a traffic department. When completed this survey (which is being carried on through the agency of the various shippers' regional advisory boards and traffic associations) will point the way to further studies which affect every shipper and receiver of merchandise in the country. Numerous requests received from individual concerns as well as from traffic groups in regard to this work can not be complied with for lack of funds.

During the past year the bureau's research into the field of retail credit and causes of business failures and bankruptcies has disclosed sources of vast wastes in our economic system. Additional fact-finding studies along this line would, it is believed, point the way to large savings. One of the heavy items in the cost of distribution is the loss incurred through business failures. Economies effected here would ultimately be reflected in lower prices to the consumer.

A decidedly favorable reaction was evidenced by the trade during the past year as to the possibility of making more extended studies of the present and future supply and supplementary sources of the exotic raw materials that now represent two-thirds of our chemical imports. To carry on basic studies in connection with the hundreds of items involved, however, would necessitate expansion of the bureau's facilities. To follow the many mergers and other competitive developments abroad in the field of chemicals is becoming quite a burden on the bureau, yet the desirability of keeping currently informed focuses attention on the need for additional personnel in this instance also.

The American sawmill industry, which cuts one-half of the sawn lumber of the world, and the American wholesale-retail trade through which that great volume is marketed are seeking knowledge of the distribution of their product. Only unsatisfactory estimates are available now for many of the old-established outlets; for new users, such as makers of motor-car bodies and radio cabinets, consumption figures are even vaguer. Reliable data on both annual and seasonal consumption are needed to guide not only mill output but reforestation of wanted species.

In the marketing of foodstuffs three constantly changing factors are involved—production, stocks, and consumption; to get a better balance between them is one of the great problems confronting the

producer and the trader. Current statistics are very helpful to this end, but only a few branches of the foodstuffs industry have statistics of this kind. Apparently, however, many others are ready to furnish the needed figures if some Government agency will collect them.

Statistics are at once a highly essential tool in the conduct of business and a chart by which producers and distributors can guide their course. Although the United States has more highly developed economic statistics than any other country to-day, much remains to be done in extending the fields covered and in improving methods of presentation and analysis. Moreover, it is of great importance to our business men that American statistics should be comparable with those of foreign countries and that the volume of statistical information concerning other countries should be expanded. A number of vigorous international movements are under way for the development of economic statistics and for the promotion of statistical uniformity. A member of the staff of this bureau was the delegate of our Government to an international diplomatic conference for this purpose held in Geneva in November and December, 1928. Continuation of the bureau's participation with other branches of Government in movements for the standardization of statistical methods is desirable.

Much of the bureau's work, particularly in regard to domestic commerce, is of such a character that many trade associations and other business organizations would gladly assist financially in the phases in which they are interested. If the Secretary of Commerce could be authorized to accept such contributions, under proper safeguards, and to direct the expenditure and to account for these funds, public moneys would be conserved and the bureau would be enabled greatly to enlarge its usefulness. Authorizations of this nature are in force in the Department of Agriculture, the Bureau of Standards, and other governmental organizations.

THE FOREIGN COMMERCE SERVICE

The Foreign Commerce Service has now had two full years in which to orient itself to the new status given it by the Hoch Act and to put into effect some of the plans for expansion that had been held in abeyance. Six new foreign offices were opened last year (six were opened in the preceding twelvemonth also), at Accra, Gold Coast Colony; Budapest, Hungary; Guatemala City, Guatemala; Mukden, Manchuria; Oslo, Norway; and Winnipeg, Canada.

As a market for American merchandise the area served by the Accra office is virgin territory; but it is rich in natural resources, and past experience has demonstrated the value of the early establishment of an office in such fields. In addition to developing markets for American goods, this office is now furnishing long-needed information on the production of cocoa and palm oil (of which West Africa is the principal world supplier), the importance of which data can be readily measured by the widespread and growing use of these products in the United States.

Until September 10, 1928, the Vienna office, established several years ago, served the whole of the former Austro-Hungarian Empire. The economic recovery of Europe and revived interest in foreign trade made it advisable then to divide the territory and place an office in Budapest. Many opportunities for trading in Hungary that were brought to the attention of American exporters last year would have been lost had this post not been established.

Prior to the opening of the office in Guatemala the bureau had had representation at only one place in Central America—at Panama City. The new Guatemala office covers not only the Republic of Guatemala but extends its activities into British Honduras, Honduras, and El Salvador as well. Dollars-and-cents accomplishments already reported are particularly gratifying in view of the comparatively low purchasing power in this area.

The rich natural resources of Manchuria bid fair to make of Mukden one of the most productive of the smaller offices of our service. Prospects are bright for the extension of American export trade there.

The Oslo office, which, like the one at Mukden, has been established only six months, serves territory that formerly was covered from Copenhagen. In addition to the information which the new office will supply on specific opportunities for the sale of American goods, American interests should benefit by the reports which it will forward on the pulp and paper industry. Oslo being an important center of this industry, the office there will act as a clearing house for northern Europe for information pertaining to this subject.

The record development of the Prairie Provinces of Canada and the many trade inquiries coming to the bureau from that section were the determining factors in placing an office at Winnipeg. The gratifying results apparent in its first few months have more than justified its establishment.

To take care of the manning of these new offices and to provide a larger force for certain of those already established 29 new Foreign Commerce officers were appointed last year, bringing the bureau's foreign field staff to 187, assigned to its 56 offices in 44 countries. The personnel consisted of 36 commercial attachés, 21 assistant commercial attachés, 56 trade commissioners, 49 assistant trade commissioners, and 25 American clerks.

CLOSE CONTACT MAINTAINED WITH INDUSTRY

Direct contact with industry on the part of the Foreign Commerce Service is established through the extensive traveling in the United States of returned officers, who visit the principal industrial centers to confer with individuals and organizations interested in export trade. It is estimated that last year 12 industrial centers, on the average, were visited by each such officer and that in each city 20 or more interviews were had with firms and individuals, in addition to numerous addresses before chambers of commerce and other trade bodies.

As a result of such contacts business executives are making greater use each year of the services available from these offices, particularly

when traveling abroad. Evidence of this is found in the increasing number of letters of introduction (over 500 last year) given by the Washington and district offices to American business men embarking for foreign countries—and, conversely, by our overseas offices to business men in their respective territories contemplating a visit to the United States. More than 250 interested foreign buyers were thus introduced to Washington headquarters and the district offices and interviews arranged for them with suitable manufacturers, to say nothing of the numerous trade delegations which visited this country and for which the bureau, at the request of Foreign Commerce officers, planned itineraries, or at least offered them the facilities of its district offices.

ADJUSTMENT OF TRADE DIFFICULTIES ABROAD

While the large firm, with a well-developed export program and organization, does not need to call upon the bureau for collaboration to the same extent as does the small firm or the beginner, there is one class of bureau service of which the large and the small avail themselves alike—protection of interests. Study and a thorough understanding of the commercial, tariff, and trade-mark laws of the country in which he is stationed enable the field officer to intervene, when such course is proper, in disputes that call for friendly representations or explanations. The steadily increasing demand for services of this character is probably the best indication of their value to American business interests.

By explaining the "other side," disruption of otherwise satisfactory agency connections has been avoided in innumerable cases, thereby contributing directly to the success of American sales efforts. In effecting the collection of overdue accounts and straightening out a variety of other claims the foreign office, while not functioning as a collection agency, has often succeeded after other means have failed; and toward the end of reducing to a minimum claims arising from bankruptcy it has reported to interested American firms those foreign business houses in liquidation or verging thereupon.

As in previous years, the Foreign Commerce Service has succeeded in removing many obstacles to the normal development of commerce between the United States and foreign countries arising from regulatory decrees affecting American commercial interests, such as consular and customs procedure and related regulations, restrictions, and charges, incorrect tariff classification of merchandise, and import quotas. Economies that may be calculated in terms of hundreds of thousands of dollars have been effected in behalf of American trade. Regulations considered discriminatory to American merchandise have been altered following explanation by bureau representatives, and more reasonable tests of American foodstuffs, pharmaceutical products, etc., have been obtained. Business, financial, and technical concerns frequently have sought bureau advice and assistance on legal, financial, and commercial details concerning their projects, and assistance has been given them in connection with many difficult matters that involved dealings with foreign governments.

PROTECTING AMERICAN TRADE-MARKS

Trade-mark protection has continued to have the systematic attention of the bureau over the past 12 months, and the innumerable instances in which American firms have been prompt to take precautionary steps to maintain their rights reflect the value of this service to our exporters and traders. Under the trade-mark laws of many countries it is an easy matter to obtain control of valuable trade-marks, no requirement other than the filing of an application being necessary to confer upon the applicant, if no protest is lodged, exclusive use of the mark and the right to all royalties under it. The bureau's foreign offices have continued to notify American manufacturers of attempted infringements in time to prevent registration, and in several cases succeeded in recovering trade-marks after registration had been granted to foreign firms. Established businesses have been saved, losses in investments in foreign factories have been averted, and the establishment of agency connections for the sale of many American products not theretofore represented on a foreign market has been made possible. Copyright protection, a closely related branch of activity, has also been covered by the bureau's foreign offices.

With reference to the bureau's trade-mark service a New York export house states: "As you know, we represent a group of American manufacturers who have large investments in trade-marks throughout the world, and your cooperation has made it possible for us to keep them thoroughly advised at all times." And an Illinois manufacturer of campers' and hunters' equipment writes: "We wish to thank you for your splendid service in sending us information with regard to our trade-mark in Argentina. We consider these data very valuable, for we are making an extensive campaign in that country, and without the information you have furnished no doubt our interests would have been endangered."

WORK OF THE DISTRICT OFFICES

During the past year new district, or branch, offices were opened in Birmingham, Ala., Charlotte, N. C., Denver, Colo., Indianapolis, Ind., Milwaukee, Wis., and Pittsburgh, Pa., bringing to 29 the number of such offices established by the bureau in the more important trade centers of the United States. These 29 "service stations" rendered 2,944,890 commercial services last year, an increase of 17 per cent over the 2,509,114 services of the year before. There were 135,044 visitors seeking information, compared with 103,694 in 1927-28; letters written rose from 241,099 to 296,437; 882,747 requests for details in regard to the specific trade opportunities notice of which is regularly given in Commerce Reports were complied with, contrasted with 708,964; and 635,933 requests for lists of prospective foreign purchasers of American goods were handled, some 60,000 more than in the preceding fiscal year.

The managers of these offices have been most energetic in their efforts to develop the practical side of the bureau's services. They

have been steadily spreading the gospel of foreign trade, and each day finds more firms within the area served by each office entering the foreign field. Said a satisfied client of one of the newer offices recently:

As you come in contact with the manufacturers of this district you are familiar with the existing conditions of this territory. We did not know the kind of service that you were rendering until two months ago. This was no fault of yours or your department * * *. When your department was created in this city we figured there must be some kind of a "catch." * * * At one time we did a good foreign business, but for the last four years we have dispensed with it. After becoming acquainted with you and your department's work and what you are doing, we are again going after this lost business.

The district office brings a vast fund of information and many more-immediate trade helps right to the business man's door. By merely telephoning the nearest office, or making a short call there, or addressing a letter to which he will receive a reply in a day or two, the business man can establish relations with an organization prepared to aid in the solution of export problems. That this service is used to advantage by many is indicated by the tenor of the letters received in acknowledgment. One firm wrote:

Again let us express to you our greatest appreciation for the efficient service performed by the Bureau of Foreign and Domestic Commerce. I only wish we had more goods applicable for foreign trade, as we could capitalize to a much greater extent, with the facilities which your office has and the painstaking work you perform.

Other letters included such phrases as: "We have used the service for only a month or two but find it of inestimable benefit in understanding foreign markets. We expect great things from its continued use"; and, "We believe that the department should be highly complimented for the increase in general service, caliber of its personnel, and the real constructive job it is doing in the face of increasing competition from abroad."

FOREIGN-TRADE MEETINGS

During the past year foreign-trade meetings under the auspices of the district and cooperative offices were held in a number of cities to discuss export problems with the manufacturers of those localities. In every case the program was arranged and the bulk of the preliminary work was done by the manager of the local office. The meetings were conducted along the lines of a convention, with group and individual conferences to which exporters brought their problems for consideration by the bureau's experts sent out from Washington and the foreign service.

At one or more sessions of each meeting addresses were made by bureau representatives on such timely subjects as Why Bother with Export? Latest Developments in European Finance, Combination Sales Arrangements, Industrialization of Foreign Countries—Its Significance, and Germany as a Competitor. The advantages to the bureau of these meetings is the personal contact thus established with American business and the presentation of new problems for it to solve.

Last year's meetings were held at Atlanta, Boston, Buffalo, Charlotte, Cincinnati, Cleveland, Denver, Hartford, Indianapolis,

Kansas City, Louisville, Milwaukee, Pittsburgh, and Rochester. As an index of the value of these meetings the following is quoted from a letter received from a firm in the Pittsburgh district:

The average man with whom we come in contact has never appreciated the value of the bureau. Neither did we before we contacted with your office. At the recent conference in Pittsburgh the signer represented this company. He had the unique distinction of representing the smallest amount of capital of anyone at the gathering, but what your bureau has done for the larger exporter was done even more so, proportionately, for us.

PRACTICAL BENEFITS FROM DISTRICT-OFFICE EFFORTS

The growing importance of the place occupied by the district office in American foreign commerce is perhaps best indicated by the 200 per cent increase in the dollars-and-cents results reported by bureau clients to these offices during the past fiscal year. One thousand and twenty-one firms—out of 23,360 served—voluntarily reported sales and savings effected through bureau service to the amount of \$42,651,854, or an average of \$41,775 per firm.

Particular attention is given by the district offices to the needs of those inexperienced in the export field, and in the above total there is included a substantial amount of introductory or initial business reported by firms that state their export department "has just been started." Concerning such service a Pennsylvania manufacturer of stoves who had the guidance of the Philadelphia district office in the early stages of his export effort writes:

Foreign merchandising was new to us. You did not stop at simply answering fully and satisfactorily the questions we asked, but secured for us information peculiarly adapted to our particular product, and the same was really invaluable. * * * We have been assisted far beyond our expectations.

SPECIALIZED AID POSSIBLE WITH LARGER PERSONNEL

In view of the daily growing demands upon the district offices every effort should be made to secure authorization for additional personnel. Although the work has almost doubled, practically all the funds granted in the past four years have been used for staffing new offices. This has meant much overtime for the older offices (16.8 days per employee last year) in order that the work might be kept up to date.

The great increase in domestic-commerce inquiries has made the assignment of domestic-commerce experts to a majority of the district offices imperative. Then, too, interest in foreign trade has deepened all over the United States, with consequent heavier demands upon the district offices for export information. To meet this situation and to better serve the 23,000 firms which currently use the bureau's facilities through these branches, it would seem advisable to strengthen the staffs by adding specialists in lines such as automotives, lumber, foodstuffs, textiles, cotton, and machinery in regions where trade in these commodities is especially important.

Further funds for travel are needed if the district offices are adequately to cover the territories assigned to them. In many districts the majority of the industries served are outside the city in which the bureau's office is located and a more frequent and intimate contact is impossible under the present appropriation.

In the pursuit of his official duties the district-office employee frequently makes use of his own car for transportation. These employees are allowed small sums for gasoline and oil, but they should be reimbursed more adequately—say, 7 cents per mile while traveling in their own automobiles on official business. An allowance of this sort has been authorized by Congress for several other governmental units.

THE COOPERATIVE OFFICE AN INVALUABLE ALLY

In addition to its regular branch offices, the bureau is aided in its efforts to make the country foreign-trade conscious by some 50 commercial organizations throughout the United States. These chambers of commerce, boards of trade, manufacturers' associations, and similar bodies maintain cooperative offices as a means of helping the industries of their respective localities by distributing export data supplied by the bureau. During the past year these offices have been unusually active and have been of material assistance to the bureau. They cooperate very closely with the district offices and relieve them of considerable work.

Thus, through its chain of 29 district and 50 cooperative offices, the bureau is linked up with all the more important industrial centers of the country.

CONCRETE COMMODITY SERVICE FOR AMERICAN INDUSTRIES

AGRICULTURAL IMPLEMENTS DIVISION

The year just ended witnessed a notable expansion in our agricultural-implement industry as a whole. Amalgamations of some of the principal manufacturing units into groups made for increased efficiency and larger output in many lines and strengthened the entire industry in both its domestic and its foreign trade position. Exports registered an increase of 28 per cent, contrasted with a gain of only 6 per cent in the preceding year.

Cooperating with the foreign and district offices of the bureau the agricultural implements division was able to take an active part in extending the export trade to its present satisfactory proportions. Sixteen thousand more services were rendered the industry last year by the Washington and district offices than in 1927-28. Over 250 specific trade opportunities (also a notable increase) were received from abroad and given distribution through the division. One well-known firm reported that bureau assistance enabled it to increase its foreign sales by more than \$22,000—a figure representing initial orders only and one which future trade is expected materially to increase. Manufacturers of tractors in Minnesota, Illinois, California, and Iowa obtained approximately \$378,500 worth of foreign business through agencies placed with the aid of bureau representatives in Bucharest, Wellington, Constantinople, Panama City, Paris, and Warsaw. A manufacturer of hand farm tools received \$6,000 in export orders as the first result of bureau efforts.

These examples illustrate the types of specific assistance which the bureau is able to give. Other services contributing indirectly to increased sales were carried on by the agricultural implements divi-

sion all through the year. A comprehensive survey of world markets for dairy machinery and barn equipment, completed during the twelvemonth, besides indicating the best markets for cream separators, milking machines, silos, and various barn appurtenances, made plain the principal sources of foreign competition in these articles, which have come to be important items in American implement exports. Furthermore, the survey pointed out the best methods of marketing such equipment and the prevailing credit situation in each country. It was also the means of obtaining valuable lists of foreign dealers in dairy and barn equipment.

Agricultural implement and machinery reporting by consular and bureau officers stationed abroad has improved greatly, particularly the quality of the material furnished on this highly technical subject for dissemination to the domestic industry. An outstanding report of the year was a bulletin on the market for agricultural implements and machinery in Australia. Other important published material consisted of articles on market conditions in the principal countries of the world and statistical discussions of United States exports, which appeared in Commerce Reports, the official weekly publication of the bureau; Implement and Tractor Notes, a bulletin published at intervals by the division; and an unusually large number of special circulars covering a variety of subjects of interest to the industry.

Officials of agricultural implement and machinery manufacturing firms are making increased use of the division for consultation, and in consequence the number of visitors from the trade was considerably larger than during any previous year. The desirability of using factory-trained specialists to represent the bureau abroad in its agricultural-implement promotion work is being given serious consideration. If additional appropriations can be obtained to employ representatives of this type, there seems no doubt that an important service would be rendered to the industry.

AERONAUTICS SECTION

The aeronautics industry is comparatively new. Rapidly changing conditions combined with astounding growth have brought the marketing aspect of the business to a somewhat confused state. The industry is spread over practically the entire United States, there being important manufacturing centers on the west coast, in the Central States, and along the Atlantic seaboard. It is difficult for the bureau to cover this entire area from Washington, and there is need for qualified aeronautics marketing experts to be stationed in certain of the bureau's district offices to assist manufacturers and exporters with their sales problems, both foreign and domestic.

The foreign market for American aircraft is more active than ever before. If export sales continue during the remainder of the calendar year at the pace set for the first six months, this country will sell abroad some \$10,000,000 worth of aircraft and equipment, which will be three times as much as last year. There is a very active interest in American aeronautical equipment in the Far East; Europe is purchasing instruments and miscellaneous equipment if not Ameri-

can-made aircraft proper. To promote this eastern trade and properly to cover the informational side of European activities there should be aeronautics trade commissioners in both areas. The trade commissioner and assistant trade commissioner who have been studying the Latin American field for the past two years were instrumental in paving the way for the American air lines now penetrating the West Indies and Central and South America.

To meet the increased importance of the aeronautics industry the aeronautics section of the bureau expanded its services in the promotion of the industry's foreign trade and in the dissemination of information on foreign aeronautical activities to manufacturers, the press, and educational institutions. At the close of the fiscal year the mailing list for the section's Foreign Aeronautical News contained 1,740 names. The section cooperated closely with the Aeronautics Branch and with the Aeronautical Chamber of Commerce of America in the negotiations pending for the reciprocal licensing of American aircraft in foreign countries and was instrumental also in obtaining cancellation of the embargo on aircraft in one country.

Among the year's special services was aid to the Assistant Secretary of Commerce for Aeronautics in organizing the International Civil Aeronautics Conference at Washington in December, the chief of the section acting as executive officer for the conference; assistance in the establishment of an export subsidiary by a prominent aircraft manufacturer; and preparation of the foreign chapter of the Aircraft Yearbook issued by the Aeronautical Chamber of Commerce and of material for a special export edition of one of the leading aviation trade journals.

AUTOMOTIVE DIVISION

The automotive industry established during the year a number of new high production and export records—for the latter, a gain of approximately \$173,000,000 over the 1927-28 exports. The countries of the world are becoming very motor conscious and they are looking to the United States to supply the larger part of the automotive equipment they so urgently require. In turn, the manufacturers are looking to the bureau to furnish detailed, current information on both the existing world markets and those which one day will offer real outlets for American automobiles, and they do not hesitate to credit the bureau with having played an important rôle in registering the large export increase just noted. Five special automotive trade commissioners have operated further to serve the industry in strategic overseas markets.

One of the automotive division's outstanding services for the year was the preparation and practical use of a new form entitled "Application for Assistance in Securing Dealer, Distributor, or Indent Agent." The American exporter desiring foreign representation fills in this form, giving intimate particulars of his business, and it is then sent to the bureau's field officers in the territory selected. The field officer, having full and complete information in hand, is in position to recommend suitable local representation, eliminating a large amount of correspondence and saving much time. One important automobile firm states that a year ago it had 52 foreign distributors and now has 102, half of this increased activity being due solely

to the cooperation of the automotive division and the bureau's field staff. In securing 10 of these distributorships the firm spent less than \$100.

Two of the year's published studies by the division were *World Production of Automobiles* and *World Census of Automobiles*, which were universally well received. Additional sheets were distributed for inclusion in the division's *Automotive Foreign Trade Manual*, a loose-leaf manual containing statistics of imports, exports, registrations by makes, taxation, sales surveys, and a great deal of other basic information such as population, topography, highway mileage, currency, and climate of foreign countries, kept constantly up to date—a service which enables the exporter to check his true position in any overseas market.

To secure first-hand information on foreign manufacture and competition the chief of the division visited a number of European countries during the year. He and other members of the division staff attended and took part in important meetings of automotive trade associations, motor shows, and highway conventions. As a further point of direct contact between the industry and the bureau, factory representatives bound for overseas posts are visiting the bureau and remaining from one to five days collecting data on file here.

CHEMICAL DIVISION

The United States stands first among nations as a producer and consumer of chemical products and second as an exporter. It produces 47 per cent of the world's chemical supplies and ships 15 per cent of the world's chemical exports. An historical study of the development of the American chemical industry from the beginning of the present century, undertaken by the chemical division with a view to presenting an authentic statement of the status of the industry, was issued by the bureau early in 1929 and has been pronounced one of the most comprehensive essays ever published on the subject.

While there has been no spectacular rise—but a most steady growth—in our chemical exports the past few years, a change is to be noted in the character of the commodities sent abroad, the trend now being toward larger shipments of consumer products and a decline in basic materials. Foreign trade in consumer goods has been stimulated by the division's series of world-market studies on insecticides, veterinary preparations, plastic paints, dental preparations, polishes, and similar products. As an interesting side light on the value of these studies, household fly sprays, a totally unknown industry a few years ago, are now being exported at the rate of \$3,000,000 annually.

"Cartellization" (or "control of an industry through a voluntary association of its constituent independent enterprises for the joint regulation of production and distribution") has taken place to a greater extent in the chemical industry than in any other, and the division is devoting increasing attention to this vitally important economic trend. Since the chemical industry is basic to all industry, the formation abroad of national and international chemical cartels is of widespread significance, and this finds its reflex in the mounting volume of service which the chemical division is called upon to

render to bankers, financiers, economists, business men in other branches of industry, and to students of public affairs.

Foreign monopolies controlling essential raw materials have always been a matter of deep interest to the American chemical industry, inasmuch as exotic raw materials (not all of them under monopoly control, however) represent two-thirds of our total chemical imports. Because of limited facilities the division's work of the year in this field was confined to one monograph on the subject of iodine.

Distribution and other problems affecting domestic commerce are becoming of increasing importance in the work of the chemical division. Many trade associations are making special studies of preventable wastes, and the division has set up a special section, in charge of a qualified expert, to handle matters of this kind in so far as its facilities permit. Surveys of drug-store merchandising, such as that carried out for the grocery industry, and of paint merchandising suggest themselves as fields where lower cost of distribution should result through simplification, and many other suggestions have been made as to fields for study in a domestic-commerce program.

ELECTRICAL EQUIPMENT DIVISION

"Following 12 years of laboratory study and intermittent experimental work, radio broadcasting has now had nine years of public development. In this time it has become a part of civilization exceeded in importance by few other contributors to the advancement of the human race. * * * During the past seven years over \$50,000,000 worth of American radio goods has been sent to foreign countries; in 1925 exports amounted to \$9,903,787; in 1926, \$8,749,453; and in 1927, \$9,182,414. In 1928 a new record was set, with exports valued at \$12,061,410."

The bulletin from which these sentences are quoted, *Radio Markets of the World, 1928-29*, prepared by the electrical equipment division, scored an outstanding success. A *Directory of Foreign Broadcasting Stations* also proved popular. In the domestic field the division continued its quarterly survey of radio dealers' and jobbers' stocks, a service that is growing more and more valuable to the industry. Starting with the July 1, 1929, tabulation, stocks and sales will be shown each quarter within the wholesale areas as outlined by the *Wholesale Grocers' Atlas* (compilation of which was a major work of the bureau in 1926-27) and by type of business handling the radio sales.

As evidencing the value to industry of distribution information of this kind, the division has been solicited by the electric-refrigeration and heating-appliance groups to undertake similar quarterly surveys covering their lines. This will mean the mailing for the three surveys of approximately 100,000 questionnaires each quarter. The two additional services will start within a few months.

In the general electrical-equipment field, the series of trade information bulletins dealing with foreign market conditions now covers 22 countries. Flashlight markets abroad were discussed last year in several issues of *Commerce Reports*, where also appeared articles on sundry appliance lines; and much additional material was released

through other channels. The division still handles the Australian Electricity Commission's specifications for contemplated work open to public bidding, distributing these specifications promptly in the United States, and has continued the collection and dissemination of "Foreign electrical current characteristics," that is, voltage, frequency, source, available supply, rates, etc., of the electricity furnished in every community of the world having current.

The National Electric Light Association ("NELA") has cooperated splendidly by furnishing handbooks and bulletins for the bureau's foreign offices, thus keeping the field staff informed on electrical developments in the United States, and is preparing a Spanish translation of the handbook for use in Spanish-speaking countries.

A number of American companies were interested by the electrical equipment division in the export field, among them a well-known radio company and a washing-machine manufacturer whose whole export policy was mapped out by the division. Very definite aid was given two large telephone companies with respect to the Guatemalan situation.

The division and the district and cooperative offices together undertook a detailed study of radio dealers' methods of operation during the year, but it is not yet ready for publication. Also a survey was made of the kinds of materials used by manufacturers of electrical equipment and appliances. The panelboard section of "NEMA" (National Electrical Manufacturers Association) asked the division to assist in obtaining statistics from those manufacturers not in the association, which is being successfully accomplished each quarter. Several fruitless attempts have been made to have a census of radio sets in the United States taken, but there is still a plan under consideration which may develop favorably.

FOODSTUFFS DIVISION

West Africa produces about two-thirds of the cocoa beans of the world, yet the American trade, which imports some \$15,000,000 or \$20,000,000 worth of this cocoa annually, has in the past had no direct information service covering the harvest or the factors that affect yield and price. One of the most important extensions of the foodstuffs division's work last year accordingly was the arranging for a very complete service of reports on this crop through the bureau's new office at Accra, Gold Coast.

The rapid rise of vegetable oils as a foodstuff in recent years and the constantly increasing calls on the bureau for information made desirable the assignment to our London office of a trade commissioner specializing in fats and oils to cover Europe; and the early appointment of a citrus-fruit trade commissioner for Europe, with headquarters at Hamburg, has been authorized. Besides these new officers, there are foodstuffs trade commissioners stationed at London, Rome, Shanghai, Singapore, Panama City (for the Caribbean countries), Rio de Janeiro, and Accra, and a special commissioner on Pacific coast fruit products is traveling in the Far East.

The foodstuffs division has long desired to prepare a summary of the pure food laws and regulations, customs requirements, and trade restrictions affecting imports for the major countries to which we

sell food products. Such a survey is now well under way, a beginning having been made last year in the study on fresh fruits and vegetables and canned foods undertaken in collaboration with the division of foreign tariffs.

The tobacco section was particularly active in the introduction of American cigarettes into eight foreign countries and in developing the trade in American tobacco in three of the principal European tobacco monopolies.

Other work developed by the division in the foreign field included the setting up of a reporting service on shipments of avocados from Cuba and research into the marketing of fur-bearing animals and pure-bred livestock in several foreign countries.

In the domestic field a system for collecting monthly figures on candy production and confectionery sales was established at the request of the confectionery industry, and a start made on the collection of statistics for the mayonnaise industry; arrangements were completed for weekly telegraphic reports (to be sent to California and Florida) on shipments of citrus fruits to the United Kingdom; and numerous other statistical services helpful to industry were organized.

During the year a grocery specialist was added to the division personnel, who made a detailed distribution-cost analysis for two large grocery houses in conjunction with the domestic commerce division. The investigation disclosed a number of very important sources of loss in distribution that could be remedied and aroused much interest among wholesale grocers generally.

HIDE AND LEATHER DIVISION

The establishment of the New York Hide Exchange has created a most insistent demand for more information regarding world production and stocks of hides and skins. The bureau's hide and leather division, therefore, has started the preparation of a world raw-stock manual that will present a summary of the livestock population, the trend toward increase or decrease of herds, and the international flow of trade in raw stocks for every country producing hides and skins in commercial quantities, thus affording the importer and the tanner a clear-cut outline of the raw-stock situation in any given area. To make the manual of permanent value, it is proposed to have it carefully revised each year.

That American exporters of leather make very practical use of the existing services of the division is seen in the wider distribution of American leather; 98 foreign countries bought American leather last year, where but 70 took it in 1913, and, of these, 17 were "million-dollar markets," against only 6 such before the war. The division aided American tanners in the selection of 150 known agents during the year. Exchange of agency information between the members of the industry through the division as a clearing house proves constantly of more value.

Perhaps the outstanding new development of the year was the training of an assistant trade commissioner for service in China. Undoubtedly the most useful among the many publications issued was the bulletin on Selling American Leather in Germany, said by competent judges to display a masterly grasp of European leather-merchandising

problems. A series of fortnightly letters, accompanied by confidential circulars dealing with major questions in the exportation of leather and mailed to the chief executives in the industry, was an exceptional service feature of the last quarter of the year.

Through the untiring efforts of the very active advisory committee of the Tanners' Council of America and the hide and leather division the cooperation of the tanning industry with the various Government departments and bureaus has been greatly intensified. The inter-departmental committee for the study of domestic raw-stock conservation, which committee is composed of representatives of the Departments of Agriculture and Commerce, gained much recognition during the year for the splendid work already accomplished in the elimination of the cattle grub, the improvement in the take-off of hides, and the standardized grading of domestic hides and skins. A tentative schedule of grades has been published and is being discussed by interested groups.

The problem of a future domestic supply of tanning materials has now definitely come to the fore, and as an initial step toward its solution the council of the American Leather Chemists Association has appointed a committee of four experts to act, through the hide and leather division, in an advisory capacity to the Department of Commerce in formulating a practical program of research and education.

INDUSTRIAL MACHINERY DIVISION

American exports of strictly industrial machinery now approximate \$1,000,000 a working day—an astounding volume when the character of this equipment is considered and when it is remembered that this represents a consistent rise from a yearly total of \$112,000,000 in 1922.

The industrial machinery division was quite successful last year in its trade-promotion work; letters received from individual machinery manufacturers tell of specific instances where some \$2,000,000 worth of business was secured. These orders, placed with the aid of the bureau's foreign and district office staffs, included construction machinery for Canada, canning machinery for Brazil, excavating machinery for Latvia, machine tools for France and India, lighthouse equipment for Cuba, and sales of other machinery to Nicaragua, Turkey, Australia, and other countries.

During the past year studies were completed on the market for industrial machinery in Italy and the Netherland East Indies and (conjointly with the agricultural implements division) for dairy equipment and supplies in Great Britain and on the Continent. Questionnaires are now in the field for a world survey of the sawmill and woodworking industry and the possibilities for the sale of equipment of this class in foreign countries; and a bulletin on the Mexican Market for Industrial Machinery is now in course of preparation.

On the domestic side the industrial machinery division collaborated with the domestic commerce division in studying plant equipment in American factories, and it is hoped that preliminary reports thereon can soon be published. Efforts are being made to apply the results of the Census of Manufactures to the sales problems of the machinery industry, and reports covering this part of the work should also be available in the near future.

IRON-STEEL-HARDWARE DIVISION

The past fiscal year saw the completion by the iron-steel-hardware division of an export-market survey for domestic oil burners—a product peculiarly American, having been developed by American engineers and at present finding its widest use in American dwellings and commercial buildings. This survey, however, because of the unusual detail incorporated (detail which embraced the type of heating systems in popular use abroad, the types and availability of fuels, the characteristics of available fuel oils, and the existence of laws and regulations that might affect the use of oil burners) has already resulted in the establishment of several profitable agency arrangements abroad, and the interest of American makers concerning the marketability of their burners in foreign countries is rapidly increasing. Paralleling this study the division, with the assistance of the bureau's field officers, also conducted a survey of foreign markets for cooking and heating appliances which is receiving an enthusiastic reception.

Foreign trade in the varied products within the iron, steel, and hardware category registered a satisfactory increase. At the close of 1928 shipments of iron and steel products were greater by 30 per cent than at its beginning and hardware by 15 per cent—this improvement, in general, being maintained and even augmented in the first six months of 1929. This gain was particularly gratifying in view of the generally increased production and export sales of competing foreign countries and the intensive price competition which prevailed. While all branches of the industry were served by the division throughout the year, especial assistance was rendered exporters of black and galvanized sheets, tin plate, high-grade enameling sheets, steel rails and track accessories, scrap steel, transmission towers, water, gas, and oil tanks, metal store fronts, arms and munitions, builders' hardware, cutlery, lamps and lanterns, domestic oil burners, and cooking and heating stoves and appliances. Three trade information bulletins were published on the several phases of the Japanese iron and steel industry.

The division's weekly Foreign Hardware Trade Bulletin now reaches more than 2,100 firms interested in hardware lines. This bulletin contains information submitted by Foreign Commerce and consular officers covering both existing and potential markets and specific conditions affecting the hardware trade in each area discussed. In addition, much attention is paid to the activities of our principal competitors in the major foreign markets, and advice as to both regular and unusual sales activity is included.

Early in 1929 the chief of the division visited the Pacific and Gulf coasts of the United States, establishing a number of new contacts and renewing others of long standing. There has been, as a result, an extension of the scope of the division's activities in those sections.

LUMBER DIVISION

In the opinion of the lumber export committee (composed of representatives of the principal export groups and acting in an advisory capacity to the Department of Commerce) a better knowledge in other countries of American construction methods and the efficient use of our lumber through dry kilning, grade selection, and attention

to working stresses would materially improve consumption of American lumber abroad. As part of the necessary educational work the lumber division of the bureau cooperated in the preparation of the first two of a series of trade-extension bulletins, American Douglas Fir and Its Uses and American Pitch Pine and Its Uses, for distribution abroad by shippers of these woods, and called the attention of exporters to the very useful handbooks on Wood Construction, Seasoning and Handling of Lumber, and Sap Stains and Their Prevention, issued by the National Committee on Wood Utilization, as suitable to supply foreign agents and customers. Continued cooperation with this latter committee has considerably enlarged the division's store of marketing information, and close touch has been maintained with the work of American lumber associations as well.

Besides the publications just mentioned, the division issued a 340-page bulletin on the British lumber trade; revised bulletins on lumber-import methods in South America and in Germany, Italy, and Spain; prepared a handbook on lumber exporting and a pamphlet on department services to the lumber industry; paid particular attention to press releases and articles for Commerce Reports; and in collaboration with the division of foreign tariffs issued a special circular giving the import duties levied on sawn lumber in all major foreign markets. During the year a series of monthly circulars covering hardwoods, Southern pine, etc., was inaugurated. A new Directory of Exporters of American Lumber was issued, exporters were listed on new, specially designed species-products file cards, domestic references on wholesale-retail lumber trade were compiled, and plans made for domestic distribution surveys when funds become available.

In addition, the division during the year complied with 675 requests for information regarding foreign agents, mostly from established firms interested in new outlets or replacements for unsatisfactory present representatives. Experience indicates that one-third of such suggestions made by the division result in at least trial arrangements, so that over 200 connections probably were obtained for American lumber shippers last year without cost to them. Annual revision of the division's foreign-agency file was carried out in conjunction with American lumber exporters. Consultation of this file prevents two or more exporters of the same kind of lumber from competing through the same foreign agent.

A lumber specialist was stationed at Buenos Aires to cover the River Plate lumber trade. The lumber specialist assigned to the London office collaborated with the bureau's continental offices and American consuls in Europe on lumber-trade reporting and promotion.

MINERALS DIVISION

With the close of 1928-29 there is concrete evidence that the minerals division during its first full year of separate existence (formerly it functioned as a section of the iron and steel division) has achieved definite results and provided material advantages to the nonferrous minerals-metals, coal, petroleum, and affiliated industries.

Its minerals-metals section prepared, under the direction of the chief of the division, a 278-page monograph entitled "Mineral Raw Materials: A Survey of Commerce and Sources in Major Industrial

Countries." As this work covers in detail world distribution of the principal nonferrous minerals and metals that enter international trade, the report unquestionably will serve for at least five years as a ready-reference text not only for the economist but also for persons actively concerned in international trading in mineral raw materials.

The special service of the section to the tin and antimony trade in the form of regular weekly and monthly cables covering shipments of these metals from producing countries illustrates the desire on the part of the trade to obtain, through official sources, current statistical data of vital importance in the conduct of everyday business. There were also issued during the year bulletins on the marketing of manganese ore, antimony, mercury, and tungsten; and, at the direct request of the interested trades, world surveys on mica, tin, copper, and lead are scheduled for the immediate future.

Prior to January, 1929, the activities of the minerals-metals section were largely directed toward the promotion of import trade in those raw materials of which the United States has a supply inadequate for domestic requirements. Since the first of the calendar year there has been an increasing demand on the part of American manufacturers for service that will aid in the development of foreign markets for their finished products. In this connection, a bulletin surveying possible outlets in Canada, Mexico, Central America, and the Caribbean area for cement, tile, roofing materials, pipe and boiler covering, and brick will appear within a few weeks. This initial work was conducted at the request of American exporters of building materials. Similar publications for other geographical areas are planned.

The petroleum section of the division issued during the past fiscal year a monograph entitled "International Trade in Petroleum and Its Products," for which there was an immediate demand for 5,000 copies. The trade has found this report so useful that, through the American Petroleum Institute as a representative agency of the industry, it has asked that the bulletin be revised and published annually hereafter. The section likewise issued a bulletin on Petroleum Refineries in Foreign Countries, 1929, of which 4,500 copies were sold. This, too, will be revised and published annually; and World Prices for Gasoline, Kerosene, Diesel Oil, Fuel Oil, and Bunker Coal will be revised semiannually.

A report on Fuel and Power in Canada, with Special Reference to the Factors Affecting American Coal, was issued by the coal section as the first of a series that will embrace the United Kingdom, Germany, France, Belgium, and Italy. By maintaining close touch with the United States Coal Exporters Association and other organizations representing the coal industry the section is able to direct its attention to problems of current interest.

MOTION-PICTURE SECTION

The revolutionary changes in the motion-picture industry brought about by the large-scale production and exhibition of sound films caused the work of the bureau's motion-picture section to undergo considerable modification from what had been originally planned. The advent of the sound film diminished in value much information

previously collected but of use only to producers and distributors of silent pictures and heavily increased the demand for information on the prospects of marketing both sound films and reproducing systems abroad, with the further result of widening the section's circle of contacts through inclusion of companies making sound apparatus.

In order that the bureau might adjust its services to the changed conditions in the industry, the chief of the motion-picture section went to Hollywood in September, 1928, to ascertain exactly the type and extent of the data most urgently required, and thereafter the section concentrated its main efforts on supplying the material vital in the present circumstances. Thus special supplementary reports on sound films occupied a prominent place in the various publications of the section throughout the remainder of the fiscal year. These publications included 6 trade-information bulletins on Australia, India, and other countries of the Far East, 31 foreign-market bulletins, and feature articles contributed to the trade press. The survey of the European motion-picture industry inaugurated the previous year was brought up to date and republished with much additional material.

A number of special services were rendered during the year. Chief among them were a survey conducted to determine the contribution of the motion-picture industry to the prosperity of other industries; cooperation with State Department officials in dealing with legislative problems affecting motion pictures in a number of foreign countries; the procuring of representative industrial films for use at the Seville exposition; advice in the establishment of the foreign sales organization of a manufacturer of sound-recording apparatus; and preparation of lists of theaters abroad of a type in which reproducing apparatus might be installed.

New contacts were made in the motion-picture equipment trade and an advisory committee was set up. Two bulletins on the prospects for equipment sales in Europe and Latin America were published, as well as a number of smaller pamphlets on individual markets.

The industrial and educational work of the section was broadened. Much useful information on the sources of American nontheatrical films was given out to a constantly expanding group of inquirers, who included representatives of several foreign governments. The Composite List of Nontheatrical Film Sources is being revised and enlarged, and a questionnaire is being issued to several thousand schools designed to show the extent to which visual education is being employed in them.

The motion-picture trade commissioner assigned to Europe was called upon during the course of the year to report and advise on difficult legislative situations affecting motion pictures in several continental countries. He submitted over 150 market and statistical reports which formed the basis of many of the most popular publications of the section. The work of the bureau's foreign offices was equally effective; the commercial attachés in Austria, France, Germany, Hungary, and other countries where film control was in force or contemplated rendered splendid service in advising the trade how these regulations might be met. The same applies to the trade commissioner in Calcutta where a similar situation exists.

PAPER DIVISION

Expansion of production marked the paper industry last year, and exports of practically all lines made greater gains than in any twelvemonth since the war. The movement toward cartellization noted under "Chemicals" is encountered also in the paper industry of Europe, and steps have been taken by producers in this country to reach an agreement regarding foreign markets with members of the European industrial group.

Manufacturers of paper and paper board, and of printing machinery and supplies as well, were actively assisted by the paper division of the bureau in finding outlets for their products abroad and were kept informed of changes in foreign economic and trade conditions. Inquiries relating to export markets answered during the year through Washington and the district offices numbered 34,970, or nearly 30 per cent more than in 1927-28. While this increase was spread fairly well over the entire group of products, perhaps the greatest proportionate gain was in inquiries concerning markets abroad for specialty goods and in connection with domestic distribution.

The limited personnel of the division makes it desirable to foster cooperation with industry through the medium of trade associations, but it has been handicapped in extending assistance to the printing equipment branch by lack of an active organization there, necessitating the establishment of contact with trade publications and individual manufacturers. The division was able, however, to help several printing equipment concerns in placing agencies overseas.

Besides articles appearing in Commerce Reports, items of special interest to the trade were published in the division's Weekly News Release, and a revised edition of the Glossary of Paper Terms and Instructions to Exporters was issued. Trade information bulletins covering New Zealand, Australia, the Near East, and part of Europe are planned for publication during the next half year.

The new office recently opened by the bureau at Oslo, Norway, has contributed much valuable material to the division's file of information on the paper industry of northern Europe. Already the commercial attaché has established contacts with European trade associations that will be of practical advantage to the bureau.

RUBBER DIVISION

The past fiscal year was marked, on the one hand, by the anticipated high rate of rubber production following the end of the export-restriction policy that had been in effect in British Malaya and Ceylon since 1922, and on the other hand by an unforeseen equally high world rubber consumption, in consequence of which current statistics of world rubber production and consumption were more than ever necessary to the American trade.

To meet the situation the division's statistical services on rubber were broadened through cabled reports on shipments from producing centers and imports into manufacturing countries, by official reports of month-end quantities of rubber afloat for the United States, and by elaboration of the United States export classification

covering rubber products. Fresh information about trade developments was supplied through special circulars issued weekly. Special surveys were made of consumption of crude and reclaimed rubber in the United States during 1927 and 1928. A considerable improvement in the timeliness and accuracy of statistics published in the trade press was a natural corollary of these activities. Semi-annual conferences were held with leading statisticians representing rubber manufacturers.

To assist the rubber footwear industry in this country the division has arranged to make surveys of stocks of such footwear in dealers' hands at stated intervals, following the compilation of similar statistics for manufacturers' stocks through the Rubber Manufacturers Association. The first survey was made as of June 30, 1929. This service is similar to the survey instituted in 1924 for tire stocks, which continues to be conducted semiannually by the rubber division.

The year's publications by the division included bulletins on European Markets for Rubber Sundries and Specialties and British Colonial Office Reports on the Rubber Situation, besides regular weekly news letters on the import trade in rubber and export trade in tires and monthly circulars on the export trade in rubber footwear, mechanical rubber goods, and rubber sundries and specialties. Mimeographed material consisted of 370 circulars, 91 statistical statements, and 47 corrections to the division's manual giving rates of customs duty applicable to rubber products upon importation into foreign countries. The manual of statistics on foreign trade in rubber footwear and rubber heels and soles was revised and will shortly be released.

SHOE AND LEATHER MANUFACTURES DIVISION

Within the purview of the shoe and leather manufactures division there are, besides leather footwear of all kinds, the related lines of lasts, welting, and findings; and gloves, harness and saddlery, luggage, leather belting, leather novelties, and others. That the division has been able to create interest and to present possibilities of foreign trade advantageously to exporters of all these articles is shown in the markedly larger number of inquiries received by it last year. A change, too, is to be noted in the character of these inquiries—formerly for general data, now for advice on more intimate phases of trading. As adviser in this latter capacity the division was able materially to aid manufacturers seeking foreign markets in planning sales campaigns for new territories.

Specific opportunities to sell leather goods abroad increased 30 per cent in the last six months over the number called to the attention of the trade in the first six months of the fiscal year and ranged from useful footwear to small pieces of scrap leather. Since foreign consumer preferences can best be determined through personal survey and analysis, to supplement the information submitted by consular officers and the bureau's field staff the chief of the shoe division spent three months in Europe last year studying present footwear trade possibilities and trends.

The division, however, is being consulted more and more in connection with the domestic sales situation. Distribution, or selling, is the big problem confronting American shoe manufacturers to-day.

From 90 to 95 per cent of their production must find an outlet through domestic channels. Consideration is being given to obtaining quarterly or half-yearly reports, by class and grade, of manufacturers' output and dealers' stocks-in-hand. These figures when compared with the population and the age groups of population in the country would point out the localities of saturation and of shortage and be of great assistance in determining where to concentrate sales effort.

The cordial cooperation with other governmental agencies which has characterized previous years continues, particularly with the Army Quartermaster's Department, to which advice is regularly given as to the best time to purchase shoes for the Army and also as to when surplus stocks of footwear, harness, saddlery, and other leather articles could be disposed of most advantageously.

SPECIALTIES DIVISION

Approximately \$200,000,000 worth of American specialties (or \$15,000,000 more than in 1927) was shipped to other countries last year—a figure that indicates, in some measure, the importance of the group of unrelated commodities handled by the specialties division. Contributing to this total were the first sales of manufacturers who previously had done no exporting, but were helped by the division to a definite start in developing foreign outlets on a permanent basis, as well as the shipments of veteran exporters who further extended their trade abroad by the establishment of added agencies or branch offices and by more intensive work in areas already covered. This has involved a larger use of advertising as an aid to sales and brought about a decided increase in the advertising services rendered by the division, whose store of information on foreign advertising media and methods is being drawn upon more and more by American manufacturers, exporters, and advertising agencies.

Requests for general trade information likewise are increasing, to meet which last year the division greatly extended its services in the way of prompt dissemination of facts and figures of interest and by keeping makers of all specialty lines posted on the possibilities of developing new or unusual fields. As an outcome of this direct service the division has received reports of definite dollars-and-cents results which, it is interesting to note, include sales of such diverse articles as fire extinguishers, furniture, ash receivers, trophies, advertising novelties, compacts, playing cards, books, picture frames, office supplies, and phonograph-record cleaners.

As in the past the division maintained close contact with industry through representative trade associations as well as individual manufacturers and groups of manufacturers. Especial emphasis has been given to anticipating the requirements of the industries served, an example of which is to be found in the studies carried on relating to coin-operated mechanisms and possibilities for the sale of machines of this type in foreign countries. As a result a gratifying number of manufacturers have been able to develop some good export outlets. Further, a new classification covering these machines was set up in the official United States trade returns, that some indication could be had of the volume of foreign sales in this new export. From January 1 to June 30, 1929, these amounted to \$463,570.

There is every indication that future increases in this trade will be substantial and that the service inaugurated by the division for this industry was well worth while.

TEXTILE DIVISION

Keen competition and slack demand have caused the selling of textiles in foreign markets to become increasingly difficult and led the textile division to intensify its trade-promotion work throughout the whole of the past fiscal year. To this end it maintained close contact with the various textile associations and through them called to the attention of the proper firms many specific opportunities for trading, forwarded numerous samples to the bureau's foreign offices for inspection by prospective purchasers or agents, and made available to American concerns an increased volume of trade information either directly or through published reports. Substantial results followed.

The American rayon industry surpasses that of any other country of the world in volume of output, but up to the present time it has produced almost entirely for home consumption. Output has been expanding at a rapid rate, however, and there is now a possibility that production may overtake consumption here. In an endeavor to find suitable markets abroad for any exportable surplus the textile division, at the request of the industry, conducted a survey of rayon sales prospects in Central and South America. The information thus obtained and suggestions as to the proper methods for entering the most encouraging of these markets were supplied to interested manufacturers.

The textile division also undertook, in cooperation with the Buenos Aires office, an investigation of the market possibilities for American-made fur coats in Argentina. As a result of this survey a large consignment of fur coats will go to that southern Republic before the end of 1929. The fur section of the division published a bulletin on the International Trade in Furs which supplies much-needed statistical data on the subject.

In the domestic market the division's principal service to the textile industry was in facilitating business between the Government and textile manufacturers and in collaborating with the various institutes and associations in the trade on a number of important projects. The chief of the division is chairman of the technical committee on textiles of the Federal Specifications Board, the principal function of which is to devise master specifications for the textile requirements of the Government. These specifications, so far as possible, call for materials of standard commercial constructions and thus permit freer bidding on the part of textile manufacturers and assure maximum returns to the departments for the money expended. During the past year the committee promulgated 19 approved specifications and drew up 19 tentative ones for later consideration by the board and the industry.

The new uses for cotton section of the division continued its investigation of current and potential uses of cotton in the building, awning, leather-shoe, automobile-tire, and citrus-fruit industries as well as a number of other enterprises. Its conclusions, published in pamph-

let form, were given wide distribution. Suggestions developed through these inquiries have been made the subject of further study and technical research by cotton manufacturers.

At the request of the National Association of Dyers and Cleaners the textile maintenance section of the division cooperated in a study of the controversies arising between department or dry-goods stores and cleaning establishments as a result of the fading or shrinking of fabrics in the cleaning process.

The fur section, in cooperation with State game commissions, the Department of Agriculture, and the National Association of the Fur Industry, made the second tabulation of the value of the annual fur catch in the United States.

SPECIALIZED TECHNICAL SERVICES TO BUSINESS

COMMERCIAL INTELLIGENCE DIVISION

The work and functions of the commercial intelligence division are to act as the bureau's clearing house of information respecting foreign business firms of all classes; to respond to inquiries from bureau clients as to who are logical distributors for their products in the trading centers of the world; to be informed on the buying terms customary in foreign markets, and on sources of credit information; to keep a record of failures, liquidations, and bankruptcies of foreign buyers, and of concerns that resort to fraudulent business practices. Commercial intelligence such as this is a perishable commodity, its prompt and accurate dissemination a necessity. The record achieved by the division during the past year was made possible only through the excellent support received from the consular officers of the Department of State and the field staff of the Bureau of Foreign and Domestic Commerce.

The trade-list service, the oldest activity of the division, has advanced to the point where the names and addresses of over 600,000 foreign buyers—importers, wholesalers, commission merchants, brokers, and large retailers—of some 3,200 separate commodities are on file. Four hundred and seventy-two new listings were added last year, and approximately 700,000 of the lists sent out to bureau clients upon specific request therefor.

The supplying of detailed reports on individual concerns abroad (known as World Trade Directory reports) continues to be the most important activity of the division. The master file now contains reports on nearly 400,000 foreign firms, 44,687 new reports having been added in 1928-29; more than 148,000 requests for information of this character were received during the year. As a measure of the confidence reposed in the division and as showing how users of the service cooperate, it is interesting to note that American exporters, banks, and credit and trade organizations furnished the division with over 30,000 reports respecting their trade experiences with foreign firms to add to this file last year.

In investigating the fitness of foreign agencies to handle the selling franchises of American exporters data have been collected which enable the division to suggest suitable sales agents to meet specific needs. Over 3,000 such requests were handled last year and satisfactory results reported.

The division has recently made an extensive study of buying terms current in the trading centers of the world in respect to the major commodities exported from the United States. The data now available to American traders have never before been recorded in such detail. They indicate that American exporters generally are collecting for shipments to foreign buyers by means of documentary time drafts payable at definite due dates and that they are not finding it necessary to extend as long credit terms as do their foreign competitors in many of the world's markets.

Sources of credit information to enable the American exporter to "rate" the foreign buyer as a credit risk have been investigated by the field staffs of the Departments of Commerce and State. All reliable sources existing in each foreign area as well as in our own country have been listed and made available to shippers as a trade-information bulletin, Sources of Foreign Credit Information, now in its third edition.

Some 9,000 specific opportunities to sell American products were received in the bureau last year from buyers abroad and checked in the commercial intelligence division as to the responsibility and standing of the inquirer before publication in Commerce Reports and the press of the country.

DIVISION OF COMMERCIAL LAWS

A memorable contribution toward the codification of commercial law, which has long been the objective of international jurists, was made by the division of commercial laws last year through the services of the chief of the Latin American legal-information section, who, at the request of the Chilean Government, attended a series of conferences with its experts and legal authorities called for the purpose of revising the Commercial Code of that country. The section is also cooperating with the American section of the International Chamber of Commerce in matters affecting *c. i. f.* contracts as interpreted under the Warsaw Rules of 1928. The bulletin on Argentina which the section last year contributed to the series on Trading Under the Laws of Foreign Countries was one of the most comprehensive yet issued.

In the main the work of the European section of legal information had to do with incorporation and tax matters. Domestic legislation in the several countries of Europe was analyzed and American exporters informed of the benefits thus accorded their foreign enterprises. Studies were also made with special reference to the elimination of double taxation. A monograph on the intricate subject of Taxation of Business in Italy by the chief of this section appeared at the close of the fiscal year. Research is now being conducted to determine what protection may be afforded American shippers under drafts payable to collecting banks in foreign countries, and also with reference to European inheritance taxes and death duties.

Due to limitation of personnel, assistance given American firms doing business elsewhere than in Latin America or Europe has been limited to cooperation in the solution of specific problems. Although very desirable, it has not been possible to conduct extended research regarding the laws of Asiatic, African, and Oceanic countries.

In the field of industrial property the services of the patent and trade-mark section increased approximately 50 per cent during the twelve months, its antipiracy work having trebled through investigation of more than 3,000 notices of application for registration of trade-marks apparently American. The benefits of this service are attested by hundreds of letters of appreciation; its dollars-and-cents value can be gauged only by the worth attached to the trade-mark or trade name by the firm concerned. Recently the section has undertaken also certain studies relating to unfair competition.

The work of the insurance and trade-adjustment section increased 65 per cent. Cooperation toward removal of misunderstandings was extended in over 1,000 cases. The great majority of these difficulties were reported to the bureau after all other efforts at adjustment had proved futile; yet, notwithstanding this, and although the section's activities are limited to friendly representations, recovery of more than \$200,000 was effected through cash payments, repossession of merchandise, fulfillment of prepaid orders, and replacement of defective goods. Other problems amicably solved involved such misunderstandings as conflict of agency or sales territories, the results of which adjustments can be measured only in terms of good will.

In its various endeavors toward removal of misunderstandings, reestablishment of commercial confidence, and resumption of business relations between American firms and their estranged customers the division has enjoyed the cooperation of trade associations and local chambers of commerce; toward elimination of the commercially unfit, the cooperation of appropriate governmental departments and Better Business Bureaus has been successfully enlisted. The division's list of more than 6,000 attorneys practicing in 450 foreign jurisdictions has recently been revised, and now an attempt is being made to record the names of American attorneys having foreign correspondents.

The past year saw increased restrictions upon American business, occasioned by nationalistic trends in insurance matters. The development of workmen's compensation and various forms of industrial and social insurance has placed additional burdens upon American capital in foreign territory. These conditions have necessitated the initiation of efforts, though with limited personnel, toward protection and promotion of American insurance interests abroad, toward informing American business regarding foreign insurance legislation, and toward protecting the American insuring public against unreliable foreign concerns seeking to operate in the domestic field. The immediate need for such cooperation is evidenced by the fact that in the three months since its institution over 200 services have been rendered at the request of foreign governments, State insurance officials, insurance associations and companies, and individuals.

DIVISION OF CORRESPONDENCE AND DISTRIBUTION

Prompt handling of a variety of correspondence relating to the foreign marketing of American products and the development of the country's domestic commerce, reviewing letters prepared by the commodity and technical experts of the bureau, disposition of a mass of

constantly arriving inquiries, and maintenance of mailing lists to aid American business men are among the everyday services of the division of correspondence and distribution. Although here grouped with technical divisions for reasons of typographical convenience, the correspondence division is, more strictly, an administrative division, one of its important duties being to see that administrative rules and regulations dealing with questions of general policy, as well as more detailed administrative problems, are complied with by all units of the bureau for the smooth functioning of the organization as a whole.

During the year ended June 30, 1929, 220,131 letters were received in the correspondence section of the division at Washington and routed to the appropriate units and 230,770 outgoing letters were reviewed. These totals compare with 198,121 letters received and 193,495 outgoing letters reviewed in the fiscal year 1928, respective increases of 11 per cent and 19 per cent. Supervision of incoming and outgoing mail enables the correspondence section to observe such factors as uniform treatment of similar problems by the different units at Washington and in the field, appropriate cooperation between the several divisions of the bureau in Washington and between the Washington organization and the bureau's field representatives, the efficient handling of correspondence, and like subjects. Considerable progress has been made in the way of reduced letter writing through the use of form letters devised by the chief of the division.

The distribution section has, among other duties, the supervision of the various mailing lists of the bureau, including the Exporters' Index—that intricately classified list of eligible American firms and individuals interested in foreign trade which forms the basis of the bureau's distribution of commercial information. One of the major problems currently facing this section is avoidance of duplication. In the interest of governmental economy and efficient service to the American business public it is necessary that the hundreds of bureau mailing lists be utilized without repetitions. Constant attention to this point on the part of the distribution section has resulted in a distribution system that is carried on practically without duplication of material to any address.

EDITORIAL DIVISION

Its position as the clearing office for commercial information that is to be distributed in printed or mimeographed form enables the editorial division to correlate and coordinate the publication work of the bureau. Inasmuch as the bureau's service is almost wholly a service of information, its function being to gather data and make them usefully available to the business public, the amount of printed material which it issues must necessarily be large. Last year the equivalent of 20,000 octavo pages of printed and 50,000 pages of mimeographed and multigraphed matter was handled by the editorial division—both figures being substantial increases over the 1927-28 totals, in keeping with the expansion in the general activities of the bureau.

No new forms of presentation were found necessary, those in use for several preceding years—Commerce Reports, handbooks, trade-promotion monographs, trade information bulletins, and special and periodic circulars—having proved both adequate and popular. Certain of the major reports in these categories are mentioned in connection with the commodity and technical divisions' work, as are also the Commerce Yearbook, Commerce and Navigation of the United States, and the Statistical Abstract. A unique testimonial to the practical value of the bureau's illustrated weekly, Commerce Reports, was its adoption last year as required supplementary reading in their foreign-trade courses by two more of our leading universities; and increasing world-wide interest in commercial developments of the type therein discussed resulted in the placing of this periodical in the libraries of many ocean liners.

Sales of the Commerce Yearbook last year broke all records—more than 20,000 copies of the two volumes, representing some \$22,000 in receipts; the Statistical Abstract, too, had a most unusual sale, indicating the need for reliable statistical data by both business men and economists. Receipts from all bureau publications distributed on a sale basis by the Government Printing Office aggregated \$72,813 in 1928, or nearly 30 per cent more than in the preceding year.

FINANCE AND INVESTMENT DIVISION

From its fund of information on finances abroad the finance and investment division last year answered a somewhat larger number of inquiries than usual from prospective underwriters of foreign bond issues, from exporters regarding international credit methods, from banks regarding financial practices and conditions abroad, from intending investors in foreign securities, and from several other important classes of inquirers.

The division was active, also, in its statistical work. Arrangements were made to collect more complete statistics on foreign balances in this country and on American deposits at foreign financial centers. The results show the Nation's net export or import of short-term capital; they give also the most accurate picture ever obtained of America's international status in short-term credit and of the world's reserves of dollar exchange. The questionnaire used in this survey covers loans and acceptance operations as well as deposits; it was devised after numerous conferences with bankers and bank accountants.

A pamphlet on the American underwriting of foreign securities and one on Canadian loan corporations issued during the year were well received by the public, as were the usual reviews of the public finances of Latin American and far eastern countries. Among the mimeographed circulars which evoked special appreciation by our own bankers and extensive comment in the foreign press was that relating to the Republic of Colombia.

The division's annual survey of America's balance of international payments was further improved in many respects. It is now one of the most widely known publications of the bureau. The 1928 survey—the seventh of the series—includes a laborious compilation of comparable data for all recent years.

The division initiated an investigation of ways and means of increasing Canadian travel in this country, a source of income to our Nation of upward of \$100,000,000 a year. Measures to reduce the exorbitant discounts sometimes charged upon Canadian bank notes brought in by Dominion visitors are being studied by the Federal Reserve Board. Other branches of the Government have been requested to consider certain other measures to make travel here by Canadians easier and more pleasant.

DIVISION OF FOREIGN TARIFFS

For another twelve months inquiries and problems from American exporters in regard to foreign import duties on their products, foreign-tariff reclassifications, and customs, consular, pure-food, marking, and other regulations have been studied and answered, projects and difficulties in connection with these subjects have been analyzed, and solutions developed by the division of foreign tariffs—all essentially a continuation of similar work done in previous years.

Notable in the past year's work of the division is the progress made on special publications. A new research section was established, with additional personnel, to prepare material dealing with foreign duties and regulations on selected classes of products. Foodstuffs received first consideration, the section completing Part I of the Handbook on Foreign Tariffs and Import Regulations on Agricultural Products, covering fresh fruits and vegetables, and sending to the printer the manuscript for Part II (Canned Foods in Europe). Work is rapidly going forward on Parts III and IV, which will cover canned foods in other areas. Judging from the reception which the first volume has already received, it is evident that the handbook will be of real, practical value to the trade.

Work has been proceeding on a revision of Preparing Shipments to Latin America, issued during the previous fiscal year, the value of which is indicated by the sale of more copies of this than of any other trade-promotive publication of the bureau for years past. One purchaser wrote of his gratification at being able to obtain for 20 cents a bulletin which he would not part with for \$20. Progress has been made in the compilation of similar bulletins to cover other sections of the globe. The necessity for great detail and absolute accuracy in these publications, so that exporters may rely upon them in preparing their shipments for abroad, makes their issuance necessarily slow. The amount of research involved is voluminous, and the final drafts are sent to the foreign offices of the bureau and to the foreign consuls general stationed in the United States for verification and comment before actual publication.

The series of bulletins previously issued on the Shipment of Samples and Advertising Matter Abroad was completely revised and published as a single volume; and current information on general tariff matters was distributed by means of the division's weekly section in Commerce Reports and numerous special circulars.

As in former years, cooperation with the Department of State in the development and application of American commercial policy and the negotiation of commercial treaties and with other departments of the Government in questions involving the tariffs and trade-control measures of foreign countries demanded a considerable share of the division's time.

DIVISION OF REGIONAL INFORMATION

The division of regional information serves as the central point from which information is disseminated to American business interests with regard to economic conditions in foreign countries. Its work forms mainly a background to the commodity and technical work of the bureau; nevertheless it maintains direct contact with a large number of business executives, bankers, and export managers. Typical matters coming up for discussion or correspondence are questions as to competitive conditions abroad, problems of distribution, purchasing seasons, itineraries for a foreign sales campaign, standards of living, market possibilities, and a great variety of general economic problems. Last year a special service was rendered the United States automotive industry, through the National Automobile Chamber of Commerce, by furnishing that organization up-to-date information on economic conditions abroad.

In August, 1928, the division initiated a new periodic service, Russian Economic Notes (now issued weekly), the material for which is taken chiefly from the official organs of the various economic departments of the Soviet Government. Publication of weekly and monthly economic cables and radiograms was continued throughout the year and special articles prepared for Commerce Reports, much of this material being based on reports from the field officers of the bureau and the Department of State. Distribution was undertaken direct from Washington (except west-coast distribution, handled by the western district offices) of the China and Japan monthly trade reports prepared in our Shanghai and Tokyo offices. In addition to these and other periodic services, 43 circulars were issued on miscellaneous subjects, the most popular being the special circulars on living costs and office operating expenses in foreign countries. The weekly surveys of economic conditions in foreign countries for the use of the bureau's district offices, the monthly surveys prepared especially for the Department of Agriculture, and the monthly cables on economic and commercial conditions in the United States for the American Chambers of Commerce and American trade organizations in the Far East were all continued.

The division collaborated with the division of statistical research in the compilation of the 1929 Commerce Yearbook, contributing, as heretofore, the discussion of economic trends and outlines of business conditions in foreign countries. Among trade-information bulletins published were reviews of the resources, industry, finance, and trade of the Baltic States, budgets of European countries, industries and trade of Ceylon, economic development of Siam, and United States trade with Latin America. Several pamphlets outlined sales territories in far eastern areas; and the pamphlets on employment for Americans in the Far East and Latin America were reprinted twice, so great was the demand throughout the year for that type of information.

Work was started on a number of major publications, an especially significant work in process of preparation being a Handbook of the United Kingdom. Handbooks such as this, reviewing in detail the business practices and conditions affecting the sale of American goods

in foreign markets, are extremely useful, especially to exporters without experience of the market in question. Naturally these reviews, to be as complete as possible, should be prepared largely by competent personnel stationed abroad and necessary facilities should be provided.

The regional information division continued its studies of the international cartel situation (noted under "Chemicals" and "Paper" but embracing other fields as well) and has maintained an extensive library of information on this subject. The chief of the division prepared a survey of the international cartel movement in 1928, and is contemplating further study "on the ground" during his visit at the beginning of the current fiscal year to a number of European countries.

It has been gratifying to receive comment as to the value of the work of the division of regional information from a number of prominent American organizations. An official of a large oil company declared: "Your letter gives a more graphic picture of the situation than I could have obtained anywhere else in the world." And an important automobile corporation wrote: "The information furnished is very comprehensive and illuminating and we feel that this is a real dollars-and-cents service."

DIVISION OF STATISTICAL RESEARCH

Compilation of the Commerce Yearbook and of the Statistical Abstract of the United States is the most important work of the division of statistical research. The Commerce Yearbook, first issued in 1923, proved so useful to business men, bankers, and students of economics that in 1926 its scope was enlarged by the issuance of a second volume (in whose preparation the division of regional information collaborates), which surveys business conditions in about 70 foreign countries along the same lines employed in Volume I for the United States and contains numerous tables of world production and trade. Larger sales of both volumes in 1928 than in any earlier year attest the growing popularity of the book. In the 1929 issue of Volume II there has been a considerable expansion of the statistical material, particularly on banking and foreign trade.

The Statistical Abstract of the United States has been issued annually for 50 years, with steady enlargement of the field covered. The division also prepares bulletins analyzing the foreign trade of the United States by calendar and fiscal years and supplies business men and other inquirers with information which does not fall within the scope of the more specific commodity, regional, and technical divisions of the bureau.

Approximately 5,000 typewritten pages of translations from 14 different languages were completed by the translation section during the year. Between 500 and 600 pages of this material consisted of specifications for public bids on private and governmental work in foreign countries—a highly technical service of direct benefit to our manufacturers and exporters, to whom these specifications were made available through the interested commodity divisions. Cooperating with the division of commercial laws the section translated certain of Poland's new legislation relating to trade-marks, patents, and stock

companies. The section was also called upon frequently for translations by other bureaus both within and without the department—as examples might be mentioned services rendered the Commissioner of Lighthouses and the Civil Service Commission.

Within the year the geographic section inaugurated active cooperation with map publishers and distributors to increase foreign and domestic sales of American maps and atlases. Outstanding services of a technical geographic nature, entirely new in character, relating to climate, soil, floods, water supply, topography, etc., were rendered to several American business houses in connection with contemplated foreign investments or foreign sales. Important contributions were made to the forthcoming bulletin of the United States Geographic Board on the spelling of foreign geographical names. About 100 original maps were compiled for bureau publications. The regular circular information service was maintained for map publishers and geographers regarding changes in boundaries, place names, and nomenclature and regarding foreign maps, atlases, and globes.

DIVISION OF STATISTICS

The major publication of the division of statistics is Foreign Commerce and Navigation of the United States, the annual review of our interchange of commodities with the world at large upon which all official discussions of our foreign-trade position are based. As in former years, the report was issued in two volumes for 1927. Volume II, however, was enlarged by the inclusion of tables showing the trade of the United States with each foreign country by principal articles imported and exported.

The Monthly Summary of Foreign Commerce of the United States was issued by the division each month with the usual promptness. The flexibility of this monthly service is seen in the 87 new classifications in domestic exports and the 22 new import classifications set up during the year at the request of the industries concerned. Five of the new export classifications related to edible and 6 to inedible vegetable products (4 of the latter covering rubber), 7 related to textiles, 5 to wood and paper, 2 to nonmetallic minerals, 6 to metals and manufactures (4 of them covering tools), 15 to machinery and vehicles, and 40 to chemicals and allied products (15 covering medicinals, 12 industrial chemicals, 4 paints, 8 soap and toilet preparations, and 1 coal-tar products); of the new import classifications 2 related to animal products, 7 to edible and 4 to inedible vegetable products, 5 to textiles, 1 to machinery, and 1 to chemicals—all indicative of the division's ability to meet the changing needs of commerce.

Besides these comprehensive publications the division compiled, for the fifth time, the very popular tabulation showing the principal articles exported from each State of the Union; published weekly reports giving the exports of principal grains and flour, exports of pork products from principal ports, imports of raw wool into Boston, New York, and Philadelphia, and imports of wheat from Canada; and a special monthly report on imports into five principal United States ports of cotton cloth by commercial designations and a similar report for wool cloth. More than 250 special mimeographed statements showing exports and imports of principal articles by

countries and customs districts are issued each month to some 4,600 subscribers. All of the statistics issued by the division are compiled from master tables prepared in the section of customs statistics at New York from import entries and export declarations forwarded to it by customhouses throughout the United States.

TRANSPORTATION DIVISION

The transportation division continued to serve a dual capacity in the bureau organization, being both a technical and a commodity division. In its commodity work, with the aid of our Foreign Commerce officers and that of the Consular Service of the Department of State it promoted sales abroad of railway equipment, ships, barges, and tugs.

The shipping section of the division published in Commerce Reports semiannual surveys of conditions in the shipping industry of the leading maritime nations of the world. It continued the program inaugurated several years ago of cooperating with the United States Shipping Board in developing freight and passenger traffic for American ships. With the assistance of the American consul at Saigon it was instrumental in having established adequate and regular refrigerator service on an American line serving Indo-China. The section also did special research in connection with the ocean mail awards and for the National Council of American Shipbuilders.

The shipping research section, which is cooperating with the Shipping Board in conducting foreign-port surveys, completed two port publications—handbooks on Hamburg, Germany, and Liverpool, England—which are now in press, and also compiled a report on foreign bunkering stations. A considerable amount of research was accomplished for the handbooks now under preparation covering ports in Brazil, Argentina, and Uruguay. In connection with the foreign-port surveys and the foreign railway, inland waterway, and other transportation research being carried on by the division, it is probable that a great deal more information will be needed from our foreign offices in the future than in the past. This important transportation-research work will bring to American exporters and shipping interests desired facts concerning ports, facilities, subsidies, services, competition, etc.

The new mail-contract work of the division in furtherance of the program of the Interdepartmental Mail Contract Committee appointed by the President in April will necessarily require factual details regarding the activities of foreign countries in transportation. An augmented personnel to collect and compile them is needed. The chief of the transportation division is serving as secretary of the subcommittee on mail contracts.

Extensive research is being completed relative to Government aid to merchant shipping—subsidies and subventions by foreign governments to their ocean transportation lines.

The assistance which the division rendered the agricultural council of the Central Western Shippers' Advisory Board in its attempt to set up machinery for solving the vexing problems confronting the potato industry, by supplying information on the economies of warehousing and financing the distribution of commodities, is typical of both the enlarged scope of the boards and of the cooperation which the division is able to offer them.

The foreign railway section of the division continued to promote sales abroad of railway materials of all kinds, placing numerous manufacturers in touch with foreign agents; it analyzed railway finances and traffic for American firms interested in bidding on construction projects of this sort in other countries; and in collaboration with the industries concerned it is formulating plans for a research pertaining to the further development of foreign markets for railway equipment and supplies.

Comprehensive studies of foreign and domestic inland waterways are in progress, and during the past year an interim report on German and French waterways was completed. Field work for the first of the domestic studies has been practically completed, but it is desired to make a thorough research covering all inland-navigation systems of this country, weighing the merits of the development of the waterways from the point of view of their economic importance, justification, cost, and other relevant details. This inland-waterways work in the transportation division is being undertaken in line with the bureau's domestic-commerce program.

The communication section of the division cooperated closely with the Federal Radio Commission in its world-wide study of the high-frequency (short-wave) spectrum. A bulletin on Wireless Communication in the British Empire was published. Press rates for bureau messages were obtained for several of our foreign offices, resulting in substantial savings in cable tolls on messages to the department.

The division's packing and materials-handling section has been working with the simplified practice division of the department in establishing standards of dimensions for skids and lift trucks. These standards, which permit interchangeability of such equipment, when in full operation will, it is felt, effect savings approximating \$500,000,000 annually.

In its export-packing work the division continued to advise American exporters regarding this important phase of export procedure. Gratifying results continue to be shown in the domestic-packing educational campaign. During the year the railroads of the United States and Canada reported further reductions of \$2,000,000 in loss and damage claims and the express agencies for the same period cut their payments more than \$500,000. Representatives of the carriers state that a great deal of this fine showing is due to the elimination-of-waste program carried on by the division.

In its transportation field survey work the division brought to a successful conclusion its research regarding the practicability of the uniform through export bill of lading, and a bulletin was issued showing the advantages and disadvantages of the instrument.

As part of its participation in the domestic-commerce activities of the bureau the division has been conducting—at the request of industry, sponsored by the Associated Traffic Clubs of America—a general survey of industrial traffic management. Although incomplete, the data already collected disclose the need for further studies along general commodity lines, and these will be undertaken as soon as funds permit. A new section has been established in the division to carry out plans relative to analyzing the place of the motor truck in distribution.

At a meeting with officials of the Cuban Railway held in Washington the transportation division was requested to prepare certain data pertaining to the operation of weighing and inspection bureaus in the United States. The results of this conference are expected to lead to better understanding and business relationships in railway transportation between the two countries.

BUREAU PARTICIPATION IN FOREIGN CONFERENCES AND FAIRS

The bureau has contributed technical assistance at international conferences both by means of reports and by the personal attendance of advisers for some years. The quantity and diversity of this type of service have so increased of late that it became necessary to provide in one of the sections at Washington last year a clearing office for the bureau's participation in these meetings. Some of the conferences and congresses for which a considerable amount of work has been done are the Conference on International Expositions, Paris, November, 1928; Pan American Trade-Mark Conference, Washington, February, 1929; Fifth General Meeting of the International Chamber of Commerce, Amsterdam, July, 1929; Second Pan American Highway Conference, Rio de Janeiro, August, 1929; Pan American Conference on Customs Procedure and Port Formalities, Washington, November, 1929; and the World Engineering Congress, Tokyo, November, 1929.

The section prepared a bulletin on International Fairs and Expositions that presents, in condensed form, a review of the many trade and sample fairs held annually and semiannually throughout the world. To American manufacturers who now participate in these affairs as well as to those who contemplate doing so this bulletin will be of service for several years to come.

CONSISTENT GROWTH IN BUREAU'S USEFULNESS

The work of the bureau is effective only in proportion to the number of persons who make use of its services. That this number increases year by year is a source of inspiration; that the bureau serves this larger clientele with a personnel proportionately smaller and at a cost per service also less is a source of deep gratification, betokening, as it does, the loyal effort of every member of its staff.

No record can be kept of the number of services rendered by the foreign offices of the bureau, though some indication of their value is to be found in the brief list of actual dollars-and-cents results on an earlier page. For bureau offices within the United States a total of 3,342,118 services (or 11,140 each business day) was reported last year—21 per cent more than the total for 1927-28; contrasted with which are increases (for the whole bureau organization) of but 13 per cent in personnel (1,379, against 1,218) and 13 per cent also in funds expended (\$4,603,357, against \$4,067,957), and roughly (since the foreign offices are omitted from the number of services), a decrease of 6 per cent in the average cost per service.

In its many and varied activities the bureau received not only the sympathetic and understanding support of Congress but also collaboration of the finest sort from the other departments and branches

of our Government. The cooperation extended by the Consular Service of the Department of State particularly is of inestimable value. Happily the bureau is able to make some measure of return by working harmoniously and wholeheartedly with these other governmental agencies along lines of mutual interest.

The following tabulation outlines more clearly than could be stated in words the bureau's progress in the past half-decade:

Class of service rendered	Fiscal year ended June 30—				
	1925	1926	1927	1928	1929
Total services rendered ¹	2, 041, 250	1, 973, 524	2, 421, 563	2, 770, 773	3, 342, 118
Commodity:					
Agricultural implements.....	47, 841	29, 753	53, 444	75, 463	89, 591
Automotives.....	181, 606	228, 727	214, 806	236, 060	251, 392
Chemicals.....	105, 477	119, 613	122, 300	126, 007	146, 122
Electrical equipment.....	112, 245	133, 462	109, 947	117, 788	142, 526
Foodstuffs.....	142, 306	155, 301	180, 867	226, 445	247, 092
Hides and leather.....	29, 108	16, 858	26, 300	28, 200	36, 122
Industrial machinery.....	99, 038	117, 200	90, 937	94, 709	139, 304
Iron, steel, and hardware.....	112, 559	221, 252	213, 949	216, 975	236, 550
Lumber.....	70, 483	91, 393	118, 472	112, 450	128, 782
Minerals.....	53, 793	28, 172	54, 503	80, 026	92, 258
Paper.....	17, 518	11, 785	21, 861	27, 326	34, 970
Rubber.....	21, 208	14, 260	21, 790	23, 893	31, 660
Shoes and leather manufactures.....	10, 388	7, 148	12, 744	14, 740	21, 492
Specialties.....	230, 223	185, 667	134, 637	149, 748	189, 597
Textiles.....	106, 195	106, 590	124, 332	129, 139	166, 855
Technical:					
Commercial intelligence ²	(³)	(³)	(³)	(³)	119, 582
Commercial laws.....	14, 543	16, 318	16, 984	24, 543	62, 161
Finance and investments.....	15, 546	20, 578	27, 743	37, 304	43, 732
Foreign tariffs.....	27, 062	30, 031	43, 160	66, 962	89, 732
Statistics (foreign trade).....	29, 871	50, 749	37, 874	54, 166	77, 367
Transportation.....	28, 620	25, 806	36, 506	55, 956	76, 160
Miscellaneous ⁴	585, 620	362, 861	758, 407	874, 873	949, 071
Geographical classification of above, so far as feasible:					
Latin America.....	329, 737	288, 649	576, 292	703, 542	803, 155
Near East.....	52, 464	42, 718	99, 758	190, 613	111, 970
Far East ⁵	253, 875	246, 990	288, 631	300, 280	259, 860
Eastern Europe.....	53, 295	40, 390	94, 165	97, 631	114, 523
Western Europe ⁶	745, 318	831, 043	718, 324	773, 481	929, 295
Domestic commerce.....	51, 370	65, 559	61, 786	126, 196	265, 375
Foreign-trade opportunities:					
Number of opportunities published ⁷	4, 909	5, 380	5, 088	5, 904	7, 218
Number of cases in which reserved information was furnished ⁸	446, 865	437, 059	578, 343	713, 805	885, 213
Trade lists (lists of foreign merchants), number of copies furnished on request.....	687, 159	578, 524	537, 144	568, 696	690, 372
Special informational circulars (mimeographed), number of copies distributed.....	3, 713, 800	3, 327, 120	2, 583, 725	3, 659, 725	3, 626, 135

¹ Does not include services rendered by the foreign offices of the bureau nor by the cooperative offices maintained by the bureau in chambers of commerce and boards of trade in the United States.

² Bureau only.

³ Included in "Miscellaneous."

⁴ Services which could not be identified under a specific group; includes "Commercial intelligence" for all years except 1929.

⁵ In the bureau's organization this includes Australia and New Zealand.

⁶ In the bureau's organization this includes Africa and Canada (mandated territories, possessions, and dominions politically related to Western Europe).

⁷ Foreign-trade opportunities are specific openings for business in other countries, notice of which is sent to Washington by the Foreign Services of the Departments of Commerce and State and published in the bureau's weekly publication, Commerce Reports.

⁸ Confidential information relating to trade opportunities distributed only to persons and firms listed on the bureau's Exporters' Index.

As this tabulation shows, expansion in service marked every commodity and technical grouping of the bureau's work last year. Gains are to be noted as high as 44,600 in the inquiries concerning industrial machinery and 39,800 in the number regarding specialties, 37,700 relating to textiles, 24,700 to electrical equipment, 23,200 to foreign-

trade statistics, 22,800 to foreign tariffs, 20,600 to foodstuffs, 20,200 to some phase of transportation, 20,100 to chemicals, 19,600 to iron, steel, or hardware, 16,300 to lumber, 16,100 to agricultural implements, 15,300 to automotives, and 12,200 to nonferrous minerals.

But outstanding in this year of conspicuous expansion was the growth of the domestic-commerce work evidenced by an increase of 139,200 (110 per cent) in the number of services rendered by the bureau organization in this field.

It is not unnatural, then, that the bureau finds in this inventory of its 1928-29 accomplishments new incentive for future achievement.

Very truly yours,

O. P. HOPKINS, *Acting Director.*

BUREAU OF STANDARDS

DEPARTMENT OF COMMERCE,
BUREAU OF STANDARDS,
Washington, July 1, 1929.

The honorable the SECRETARY OF COMMERCE.

DEAR MR. SECRETARY: I submit herewith a brief report upon the work of the Bureau of Standards during the fiscal year ended June 30, 1929. The various outstanding accomplishments are grouped according to the subjects for which the Congress had made specific appropriations.

GENERAL ACTIVITIES

Organization.—In May the divisions of simplified practice and building and housing were moved from rented quarters of the Department of Commerce to the Industrial Building of the Bureau of Standards, thus bringing together all the commercial standardization group. The closer cooperation now possible between all the divisions of the bureau and particularly between those engaged in research and testing and in commercial standardization should prove of great benefit to all concerned. The commercial standardization group has been organized in four principal divisions: Simplified practice, trade standards, specifications, and building and housing.

Cooperation.—Most of the bureau's work is made effective through voluntary cooperation of the State and municipal governments; scientific and professional societies; trade associations; manufacturers; and individuals who accept the findings of the bureau and incorporate them into a State law, a municipal ordinance, a dimensional standard, or a standard of quality, performance, or practice. The extent of these relationships is shown by the fact that at the present time the bureau is cooperating with over 200 scientific, technical, and industrial organizations.

One of the most effective ways in which the bureau cooperates with American industries is through its research associate plan, referred to in past annual reports. At the close of the fiscal year there were 98 of these associates stationed at the bureau, representing 48 industries and associations.

Personnel matters.—As of July 1, 1929, the following will be promoted to division chiefs: E. W. Ely of simplified practice, A. S. McAllister of specifications, I. J. Fairchild of trade standards, and H. S. Rawdon of metallurgy. Mr. Rawdon succeeds Dr. H. W. Gillett, who accepted the directorship of the Battelle Memorial Foundation, Columbus, Ohio. The regular staff at the close of the fiscal year numbered 965 employees. In addition, there were 98 employees assigned to the bureau under the research-associate plan and 9 miscellaneous assignments, including guests and details from other branches of the Government, making a grand total of 1,072 persons.

The turnover was 21.5 per cent. There were 369 promotions and the average salary (\$2,413) increased by \$170. The status of the personnel shows an increase of 83 employees as compared with last year.

The contributions of members of the bureau's staff to scientific and technical progress have received public recognition in several cases. The James Turner Morehead medal of the International Acetylene Association was awarded to H. L. Whittemore for his contributions to the art of welding; the Willard Gibbs medal of the American Chemical Society to C. S. Hudson, for his work on carbohydrates; the medal of the Annual Assay Commission to W. F. Meggers for his assistance in regulating the weight of coinage; and the John A. Penton prize of the American Foundrymen's Association to H. T. Wensel and W. F. Roeser for their method of measuring the temperature of molten cast iron. I. G. Priest is serving as president of the Optical Society of America.

Visiting committee.—This committee has retained its active interest in the bureau's problems, holding two formal meetings at the bureau this past year, and making important recommendations to the Secretary of Commerce on the bureau's needs and policies, particularly in reference to the more adequate financial support of research, approval of a building program, and indorsement of the bureau's patent policies. Members of the committee have visited the bureau frequently. The present personnel of the committee is: S. W. Stratton, Gano Dunn, William F. Durand, W. R. Whitney, and John R. Freeman.

International relations.—The International Advisory Committee on Electricity met in Paris, November 20-23, 1928, and adopted resolutions proposing the establishment of an international system of electrical units based on the fundamental centimeter-gram-second system. The report of this committee was submitted to the International Committee of Weights and Measures in February, 1929, and it is understood the conclusions were ratified by the international committee at its meeting in June.

The establishment of the proposed new basis for the units will require a large amount of experimental work in the various national laboratories and a large number of comparisons between them. Standard resistance coils and standard cells have been exchanged between the bureau and the national laboratories of Japan and Union of Socialistic Soviet Republics and a standard condenser has been measured both at the bureau and at the National Physical Laboratory of Great Britain. Other exchanges are in progress, including lamps and thermocouple wire.

At a special meeting, called by the International Electrotechnical Commission, in Paris on November 16, 1928, preliminary agreement was reached on a maximum value for conductivity of aluminum wire. Arrangements were also made to collect information which might serve as the basis for establishing a standard average value for this property.

In connection with the seventh plenary session of the International Commission on Illumination at Saranac Inn, New York, September, 1928, a conference was held with representatives of the national laboratories of France, Germany, and Great Britain looking toward the removal of discrepancies between the practical candlepower standards of those countries. Provisional agreement was reached on a basic method for calibrating high-efficiency lamps. Through an interchange of lamps and colored filters progress is being made on the experimental work necessary to carry out this agreement.

Two members of the bureau's staff attended the meeting of the International Union of Scientific Radio Telegraphy at Brussels in September, 1928. The bureau will be represented at the first meeting of the International Technical Consulting Committee on Radio Communication to be held at The Hague in September, 1929. Six special committees have been appointed by the Interdepartment Radio Advisory Committee acting under the auspices of the State Department. Members of the bureau's staff have been designated as chairman of three of these committees.

At an international convention in Stockholm in 1928, at which the bureau was represented, agreement was reached on the value of the unit of X-ray dosage and its method of measurement. International action is also being taken on standard methods of protecting X-ray workers, a member of the bureau's staff serving as chairman of our national committee on this subject.

Because of urgent requests from many sources, the bureau has taken the preliminary steps to determine the advisability of attempting to reconvene the International Sugar Commission, which has lapsed since 1914. Scientific, technical, and standardization matters of the highest importance to the sugar and carbohydrate industries of the United States and other countries require consideration and could be handled in a satisfactory manner by this commission.

Two representatives of the bureau will attend an informal conference on the physical properties of steam to be held early in July in London under the auspices of the British Electrical and Allied Industries Research Association. The work in progress at the bureau in cooperation with the American Society of Mechanical Engineers will be discussed.

The international standards for grading wool set up by agreement between England and the United States have been adopted by several other countries. At the biennial meeting last spring of the International Commission on Standard Grades for American Cotton the bureau was represented on invitation from the Department of Agriculture, which acts as the official custodian of the cotton standards. These have been adopted by Belgium, England, France, Germany, Holland, Italy, and Spain.

It seems probable that international agreement will soon be reached on the standard temperature of 20° C. (68° F.) for shop gage blocks (end standards of length) as proposed by the bureau at the International Conference on Weights and Measures in 1927.

A paper on precision measurement of length has been prepared for presentation at the World Engineering Congress, Tokyo, Japan, in November, 1929. The paper treats precision length measurements from the standpoint of engineering and industry, with special applications to interchangeable manufacture and automatic gaging.

Weights and measures conference.—The National Conference on Weights and Measures, the principal agency through which the bureau cooperates with the State and local governments on matters of weights and measures administration, held its twenty-second annual meeting at the bureau June 4 to 7. The conference adopted in final form a code of specifications and tolerances for grease-measuring devices, and some amendments were also made to codes formerly adopted relative to liquid-measuring devices, liquid capacity measures, and milk bottles. It was decided to consider at next year's

meeting codes for automatic indicating scales and person-weighing scales.

Conference of State utility commission engineers.—The seventh annual conference of State utility commission engineers was held at the bureau on May 31 and June 1, and was attended by delegates from 25 States, the District of Columbia, and two Provinces of Canada. The subjects discussed included uniform types of rates and rate schedules, charges for fire protection, street-lighting rates, the rise and fall of prepayment gas meters, rural-line construction and cost, rural electrification, electric power generation, overhead wiring and radio antennas, electric-service rules, long-distance transmission of manufactured gas, branch line and switching transportation, and State regulation of common-carrier motor busses.

American Standards Association.—This body has been reorganized, and the Director of the Bureau of Standards chosen as a member of the new board of directors. The bureau is sponsor for 13 standardization projects and is represented on 71 committees having for their object the formulation of American standards.

National Screw Thread Commission.—The activities of the commission were confined largely to revision and publication of its 1928 (third) report, Miscellaneous Publication No. 89. This is considerably enlarged over former editions and contains much new and revised material. The basis thread data for the coarse and fine thread series and for the classification of screw thread fits remain unchanged, while the sections on special threads, threading tools, gages, and methods of gaging have been extensively revised.

American Gage Design Committee.—The work of the American Gage Design Committee was completed, and a report covering the design of blanks for plain and threaded plug and ring limit gages is now in the hands of the printer. This report represents the combined efforts of manufacturers and users of limit gages. The recommendations of the committee have been approved as a commercial standard and are already widely accepted by industry, even before the report is printed. The general acceptance of the recommendations of the committee will result in substantial economies in the production of limit gages.

Federal Specifications Board.—The board has just promulgated its six hundred and twenty-third purchase specification. These specifications are being used more and more by State and municipal governments, institutional bodies, and by industry. A large part of the research and experimental work necessary in connection with the formulation of specifications is done by this bureau.

Relations to Government departments.—The bureau is authorized to receive funds for specific research projects from other departments, and in pursuance of this policy in the past year the bureau has received \$339,923 for the support of 32 projects representing work for 7 Government establishments. In addition, the bureau does a great deal of consulting, specification, and testing work for various branches of the Government.

Publicity.—The Bureau of Standards Journal of Research has completed its first year and has been well received. The subscription list now numbers 5,620. The number of research papers published in the Journal was 76. Including the Journal, reprints, and all other papers in the regular series of the bureau, the total number of publi-

cations released during the year was 168. The monthly Technical News Bulletin has been mailed as heretofore. About 170 papers have been published in outside technical journals. There have also been released to the press 178 short accounts of interesting achievements, together with numerous photographs illustrating the bureau's work. The third annual number of the Standards Yearbook was published. Beginning on July 15, 1929, the Commercial Standards Monthly (previously issued in multigraphed form) will be enlarged and issued as a printed magazine available on a subscription basis, thus making available information on the progress of current standardization activities.

Testing.—The testing work for the public and Government departments continues to be a heavy drain on the resources of the bureau. The following table gives a summary of the testing activities. The work often merges with the investigational and research fields and requires in addition a considerable outlay for upkeep of reference and laboratory standards. The total number of tests was 173,512, representing a fee value of \$544,402.

Number of test items, determinations, and fee value for tests completed during the fiscal year ended June 30, 1929

Kind of instrument or material, class of test, or nature of service rendered	Number of test items for—			Total number of test items	Number of determinations	Fee value
	Public	Government departments and State institutions	Bureau of Standards			
Electrical standards, instruments, and materials.....	934	694	425	2,053	3,109	\$17,756.10
Electric batteries.....		3,668		3,668	7,686	21,725.00
Electric lamps and lighting equipment.....	318	3,329	448	4,095	4,226	21,668.48
Length-measuring devices.....	237	197	2	436	3,125	2,312.50
Gages and gage steels.....	1,735	68	492	2,295	11,096	2,255.00
Miscellaneous dimensional determinations.....	2,050	820	108	2,978	14,711	6,433.65
Weights and balances.....	5,762	1,419	1,136	8,317	18,443	7,626.50
Scales.....	4	907	2	913	26,274	44,020.00
Timepieces.....	296	39	33	368	4,728	876.00
Volumetric apparatus.....	11,323	3,779	493	15,595	29,861	11,221.70
Hydrometers.....	876	146	3	1,025	2,990	1,470.25
Density determinations, etc.....	3	51	406	460	645	1,001.00
Laboratory thermometers.....	2,492	1,111	563	4,166	17,422	9,285.10
Clinical thermometers.....	36,333	40,599		76,932	307,736	9,006.95
Pyrometers, calorimeters, etc.....	176	58	101	335	4,805	3,762.50
Insulating materials.....	80	23	46	149	149	1,125.00
Fire-resisting materials.....	3	26	12	41	100	2,572.10
Fuels and lubricants.....	287	1,489	93	1,869	10,086	17,561.50
Automotive equipment, etc.....	9	144		153	270	2,176.00
Airplane engines.....		26		26	144	32,525.00
Optical instruments and materials.....	1,205	934	144	2,283	3,394	5,142.50
Carbohydrates.....	31	1,873		1,904	2,839	3,247.50
Radioactive materials.....	1,052	13		1,065	1,065	4,490.00
Engineering instruments and appliances.....	85	1,008	134	1,227	1,310	13,373.00
Aeronautic instruments.....	27	578	38	643	3,149	8,821.00
Aerodynamic tests of models.....	20	1		21	74	580.00
Physical properties of engineering materials.....	63	2,123	60	2,246	4,400	15,068.00
Sound producing and measuring instruments.....	18	32	1	51	60	812.50
Making of special castings.....		47	217	264	834	1,676.75
Fusible boiler plugs.....		281		281	502	627.50
Metallographic examinations.....		646	106	752	3,345	6,067.00
Miscellaneous metallurgical tests.....		441	657	1,098	2,685	9,370.50
Pottery and chinaware.....	4	196	10	210	811	1,514.00
Glass.....		57	39	96	158	430.00
Refractories and heavy clay products.....		367	48	415	1,204	4,003.00
Cement, concreting materials, lime, etc.....	22	11,566	207	11,795	45,491	\$ 110,717.00

¹ Includes fee value of \$3,687.48 for inspecting 1,401,054 incandescent lamps at various factories for other branches of the Government.

² Includes fee value of \$23,821 for sampling and shipping 1,044,093 barrels of cement.

Number of test items, determinations, and fee value for tests completed during the fiscal year ended June 30, 1929—Continued

Kind of instrument or material, class of test, or nature of service rendered	Number of test items for—			Total number of test items	Number of determinations	Fee value
	Public	Government departments and State institutions	Bureau of Standards			
Stone and sand-lime brick.....		72	60	132	420	\$2,052.50
Miscellaneous ceramic materials.....	26	1,279	55	1,360	7,082	13,128.50
Rubber.....	7	1,477	38	1,542	9,417	18,481.00
Textiles.....	44	6,036	499	6,579	17,492	35,067.00
Paper.....	26	1,714	443	2,183	6,342	18,374.00
Leather.....	82	291	2	375	1,361	2,378.00
Paint, varnish, and bituminous materials.....		1,535	17	1,552	12,327	22,351.00
Chemical analysis of metals.....	1	388	238	627	2,408	4,677.50
Chemical tests of miscellaneous materials.....		1,427	110	1,537	5,154	8,231.75
Distribution of standard samples.....		618		7,430		16,360.50
Total.....	72,443	93,563	7,506	173,512	1,600,520	\$44,402.33

¹ Of these totals 229,249 determinations were for the public, fee value \$75,153.75; 348,510 determinations were for the Government department and State institutions, fee value \$427,628.38; 22,761 determinations were for the bureau, fee value \$41,620.20. The number of test items and determinations necessary in connection with the bureau's own work of research and standardization, with the resulting fee values, is not included in these totals.

SALARIES (\$648,146)

This fund provides for personal services of administration and operation; the establishment, upkeep, and comparison of standards; the development of methods of test, as well as most of the testing; and for the determination of fundamental constants of importance in physics, chemistry, engineering, and technology not otherwise provided for.

Ratio of the absolute to the international ampere.—In order to measure the absolute value of a current, the Rosa-Dorsey-Miller current balance has been redesigned and reconstructed. A special observing room has been prepared so that the observer need not enter the weighing room, new piers have been constructed in the weighing room, and an entirely new set-up has been made for measuring the ratio of the radii of the coils used in the balance. In order to measure the current in international amperes, new standard resistors have been constructed which are capable of carrying relatively large currents, and the method of measuring the potential drop over these resistors has been improved.

Ratio of the absolute to the international henry.—The inductance of certain coils is being determined in both absolute and international henries. One coil has been completed and measured. This is wound on a porcelain form and maintained at a constant temperature. Two sets of mechanical measurements have been completed and four sets of electrical measurements. The mean value of the result is: 1 international henry = 1.00053 absolute henry, with an error of not more than two or three in the last significant figure.

Magnetic testing and research.—Particular attention has been given to the standardization of magnetic-testing methods and apparatus and the preparation of suitable standard test specimens. The work has included not only testing with fields of ordinary intensity but also of very high and very low intensity.

Cooperative investigations on the relationship between magnetic properties and torsion characteristics and impact tests, respectively, were undertaken.

Electrical resistance standards.—A new type of electrical resistance standard of much greater constancy than those in general use has been developed. The greater constancy is obtained by annealing the resistance material, manganin, after being formed to final shape, at a temperature of about 600°C . in carbon monoxide at a greatly reduced pressure and effectually sealing the containing case.

Standards of electromotive force.—A new standard cell bath arranged for temperature control at any point between 18° and 35°C . has been put in operation, and measurements made to determine how well standard cells, new and old, follow the accepted international temperature formula. Significant deviations have been found. International comparisons have been made on cells received from Japan and the Union of Socialistic Soviet Republics. Cells from the bureau have been sent to Great Britain, Germany, and Union of Socialistic Soviet Republics. Thirty-four new standard cells have been constructed at the bureau, including both acid and neutral types of saturated cells. Comparisons of these with the bureau's standard group showed that the new cells agree with the present standard to about one one-hundred-thousandth of a volt. The bureau's standard for voltage is made available for public use through the medium of portable cells which are being received for certification in rapidly increasing numbers.

Standards of candlepower.—An international photometric comparison of four blue glass filters is in progress. These glasses have already been measured at the Physikalisch-Technische Reichsanstalt and at the National Physical Laboratory. When the measurements are completed at this bureau the glasses will be forwarded to the Laboratoire Central d'Electricité.

The Waidner-Burgess absolute standard of light.—This standard has been realized by the use of a hollow inclosure of fused thoria in a bath of molten platinum contained in a crucible of fused thoria. This provides a convenient standard of reference, and the measurements so far made indicate a satisfactory constancy and reproducibility. A preliminary value, based on 36 freezes is 58.9 candles per square centimeter. By observing with an optical pyrometer as well as with the photometer, data on the melting point of platinum are being obtained.

International temperature scale.—Six standard thermocouples, two from the National Physical Laboratory, two from the Physikalisch-Technische Reichsanstalt, and two from this bureau, were calibrated and have been sent to the National Physical Laboratory. Three calibrated standard resistance thermometers have been sent to the National Physical Laboratory for the first part of an intercomparison of resistance thermometers from the national laboratories.

Exchange of standard viscosity samples with the Physikalisch-Technische Reichsanstalt.—The absolute viscosities of four samples of oil, received from the Physikalisch-Technische Reichsanstalt, were determined by the bureau. The average deviation from the mean values of the two laboratories was 0.5 per cent for the two lighter oils, and 1.1 per cent for the two more viscous oils.

Constant of gravitation.—The observational work on this project has been completed. Data for 16 values of this constant have been obtained, 11 of which have been computed. The mean result of these 11 values is 6.668×10^{-8} in c. g. s. units.

Absolute determination of gravity at Washington.—A detailed study has been made of previous absolute determinations, especially that made at Potsdam. As a result of this study a tentative design for apparatus has been drawn up and construction work started.

Definition of the yard and the inch in terms of light waves.—There has been much correspondence and discussion relative to the question of defining the yard and the inch in terms of light waves. An alternative definition of the meter as the equivalent of 1,553,164.13 wave lengths of the red radiation from cadmium, under standard conditions, has already been agreed to by the International Conference on Weights and Measures, and this relation is widely accepted.

If, in addition, the yard should be accepted as equal to 0.9144 meter, or the inch as 25.4 millimeters, exactly, the present lack of agreement as to the exact relation between the units of length of the two systems of measurement would be overcome. If, at the same time, there might be international agreement that industrial measures of length should have their nominal dimensions correct at a temperature of 68° F. (20° C.), the problems of international interchangeability of parts would be completely and satisfactorily solved. Such a solution is regarded by this bureau as of very great and increasing importance.

Renewed search for a source of homogeneous radiation.—Preliminary to his comparison, in 1893, of the wave length of the red radiation of cadmium with the length of the international meter, Professor Michelson made an exhaustive search for the most satisfactory source of light. The intervening 40 years have brought forth no serious competitor of the cadmium red line. The international congress stressed the desirability of renewing the search. In light of modern spectroscopic knowledge, the effectiveness of which lies in the extensive classifications covering nearly all the chemical elements, the spectroscopist is enabled to select for more intensive study those lines which from their classification are theoretically favorable.

To this end, the bureau has been engaged in measuring and classifying the arc and spark spectra of krypton and xenon, members of the rare gas group which, on the whole, possess very narrow lines. At low temperatures (liquid air) the lines of xenon theoretically should give visible interference fringes with path differences of 50 to 100 cm. The proposed line $\lambda 5649A$, of krypton, proves to be unsatisfactory as a standard because it lacks intensity and is subject to reversal. Certain lines of krypton and xenon appear favorable as auxiliary standards, perhaps, but none compare favorably with cadmium red.

Interferometer equipment for ruling line scales.—Gratifying progress has been made toward completing the equipment for ruling 40-inch (or 1 meter) scales by interference methods. In a preliminary trial, without thermostatic control, a meter scale with lines at 10 cm. intervals was ruled in 50 minutes and found, on calibration, to be correct within the errors of observation.

In final operation, the ruling machine will be under strict temperature control and the auxiliary end gages calibrated in terms of the red radiation of cadmium. Search is being made for a scale material

having proper thermal expansion, stable in dimensions, noncorrosive, capable of receiving a satisfactory polish, and of homogeneous structure permitting the ruling of perfect lines. A special chromium steel has been obtained which bids fair to fulfill these requirements.

Intercomparison of line standards.—Each of the four platinum-iridium meter bars of the bureau was compared with all of the others and with invar meter bar No. 39. Meter No. 39 was also calibrated to decimeters and each of the bureau's four decimeter bars was compared with two decimeter intervals of meter No. 39. Each decimeter bar was also calibrated to centimeters, the first centimeter to millimeters, and a subdivided millimeter on each bar was calibrated to tenth-millimeters. As a result of this very complete intercomparison the bureau now has a much more accurate knowledge of both the relative and absolute lengths of its various precise length standards than was previously the case, and certain apparent discrepancies have been explained and eliminated.

Intercomparison of United States and Canadian line standards.—An intercomparison of length standards of this country and those of Canada was carried out, comparison being made at Ottawa and at Washington. The Canadian bars have since been recompared at the International Bureau at Sevres, France, and at the National Physical Laboratory at Teddington, England. These comparisons have confirmed the results obtained at Ottawa and Washington. As a result there is now a very satisfactory tie-up between the various national standards of the United States and Canada and those of the International Bureau.

Graduation and calibration of precision circles.—The construction of theodolites and transits suitable for first-order work, such as that of the United States Coast and Geodetic Survey, requires the graduation and calibration of circles of very high accuracy. The apparatus necessary for this work is already available at the bureau, but previous to the last year little use had been made of it. The apparatus has been put in condition for use, and trial circles have been graduated and calibrated. The results so far obtained indicate that the required accuracy can be obtained.

Seconds signals by use of the photo-electric cell.—The obtaining of accurate time signals from the Riefler clock using a photo-electric cell as a transmitting medium has been accomplished, and signals constant to about 0.0001 second are now available for distribution to the bureau's laboratories.

Design of new pendulum.—In continuation of the research on seconds signals, the bureau proposes to construct a pendulum which will give accurate seconds signals by means of a photo-electric cell and to cause the cell at the same time to close a circuit which will give an impulse to the pendulum and maintain its motion. Results so far are encouraging.

Specifications for electric time systems, fire alarms, etc.—The chief of the time section has served as secretary of the technical committee on Government master specifications for manual fire-alarm systems, electric and pneumatic clock systems, and watchman's time-clock systems. Specifications on manual fire-alarm systems and electric-clock systems have been prepared and are in the hands of the Federal Specifications Board. Specifications for watchman's time-clock systems will be ready shortly.

The chief of the time section has also served as a member of the certification committee and of the examining board of the Horological Institute of America. There are now certified watch repair men in every State, in Hawaii, Canada, and England. A total of 913 junior watchmaker's certificates and 360 certified watchmaker's certificates have been granted to date.

Glass volumetric apparatus.—Over 15,000 pieces of glass volumetric apparatus were submitted for test. Of this number 98 per cent was found eligible for test, while of that tested 93 per cent passed the test for accuracy. This is an improvement over previous years and is especially gratifying since a large part of the apparatus submitted is now made in the United States.

Fundamental constants and properties of pure metals and their alloys.—Work on the properties of very pure nickel, thorium, and rhodium is well advanced. That on pure zinc and cadmium will be incorporated in a circular now being prepared on those metals. The effect of cold working on the hardness of pure copper and other metals has been studied, and a report is nearly ready for publication. An attempt is being made to find out more about the nature of the A_1 point in pure iron by means of the beta ray spectroscopy. Plans are being laid for a comprehensive study of pure iron; what has been taken as "pure" iron in the past is now known to have had appreciable contamination from oxygen.

Development of metallographic test methods.—An automatic polishing machine, designed and built at the bureau, has worked out very successfully, giving, even with inexperienced operators, a better quality of polish on specimens for microscopic examination than can be gotten by hand save by the most tedious and painstaking effort. With the personal equation of polishing eliminated by this machine, the way is open for the study of methods and materials used in polishing.

Platinum metals.—Special attention has been given to methods for the accurate determination of the individual metals. Satisfactory procedures for the determination of iridium and ruthenium were developed, and some progress was made on the determination of osmium.

An improvement was made in the method for the purification of rhodium with respect to the elimination of minute amounts of iridium. The development of a method for the preparation of very pure iridium was resumed after several months' interruption.

Several lots of pure platinum and pure rhodium were prepared for the study of physical and mechanical properties of the metals.

Analytical reagent chemicals.—Forty-eight individual methods for the determination of impurities in reagent chemicals were investigated and in many cases modified or replaced by better methods. As in past years this work formed a material part of the preparation of specifications for reagent chemicals by a committee of the American Chemical Society.

Accelerated weathering tests.—Additional work has been done with accelerated tests to simulate weather decay of organic protective coatings. Most materials can be tested with a simple cycle of light and rain, and data on a variety of coatings are being accumulated. A simpler apparatus for determining the point of breakdown of an organic protective coating on metal has been constructed.

Tinting strength of pigments.—The tinting strength of white and black pigments is the brightening or darkening strength, respectively; but with chromatic pigments tinting strength is a 2-factor property. New names for three different factors involved in tinting are suggested; namely, chromatic, darkening, and brightening strength. A method for treating these properties photometrically or spectrophotometrically and of indicating their relative magnitude by numerical indices is suggested.

Preparation of pure rubber hydrocarbons.—Some crystalline compounds have been obtained and some pure rubber gels of high transparency have been prepared.

Molding composition for airplane propellers.—At the request of the Navy Department a molding composition has been developed for the construction of airplane propellers for use in wind-tunnel tests.

Apparatus and methods for the fractionation of petroleum into its constituent hydrocarbons.—In cooperation with the American Petroleum Institute, new types of apparatus of increased efficiency have been developed for the fractionation of petroleum for the purpose of finding the amounts and nature of the constituent hydrocarbons.

Bullkey consistometer.—A new consistometer has been developed which embodies both speed and wide range of applicability. It has been found particularly useful in obtaining information on both the unworked and worked (or broken down) consistency of oils when in a plastic condition at low temperatures.

Thin film lubrication.—It has been shown that the apparent clogging of capillaries 0.3 mm. in diameter by continuous flow of an oil, which in the literature on the subject has been attributed to formation of a rigid film, is really due to impurities in the oil. Work on finer capillaries is in progress.

Rerefining of used lubricating oils.—Both automobile and airplane engine oils have been successfully rerefined at the bureau. A commercially successful method not only saves the oil but solves the problem of disposing of what would otherwise be a waste product.

Low-temperature investigations.—To make better provision for the low-temperature investigation of the bureau, a new liquefier of larger capacity was built, a new hydrogen compressor was purchased, and cryostats for temperatures down to that of liquid air were designed and are being constructed.

Gas thermometry.—Apparatus is being designed and constructed for use in determining the mean coefficient of expansion between 0° and 100° C. of the thermometric gases, to provide new data for calculating the interval between the ice point and the absolute zero. The designs include a thermometer with no unheated space, and very sensitive pressure measuring apparatus, so that measurements may be made at low pressures.

Properties of carbon dioxide.—Some additional experiments on vapor pressure were made, and equations and tables for vapor pressure of both solid and liquid have been calculated. Apparatus for determining the pressure-volume-temperature relations has been constructed.

Molecular weights in the vapor state.—The range over which molecular weights can be determined in the vapor state has been extended by the development of a method combining vapor pressure and evaporation experiments. This makes possible the determination of molecular weights at temperatures at which the total pressure may be only a fraction of a millimeter of mercury.

Orifice-meter investigations.—Cooperative orifice meter tests sponsored by the gas measurement committee, natural gas department of the American Gas Association, with the cooperation of the Bureau of Standards and Bureau of Mines, have included tests on the effects of orifice-meter flange design; a study of the discharge coefficient of orifices in 4-inch lines for comparison with those previously obtained for an 8-inch line; and three series of tests for studying the effects of high-line pressures.

The result of the tests with different flange forms were fairly consistent, but because of the unexpectedly large effect shown, the validity of the tests was questioned by some of the companies interested. Further tests on the subject are to be made.

Density of creosote oils.—An investigation of the density and thermal expansion of creosote oils was carried out at the request of the American Wood Preservers Association, the American Society for Testing Materials, and the American Railway Engineering Association in order that the volume of creosote oils at various temperatures might be accurately calculated. The work is being continued to include coal-tar creosote oil.

Development of new apparatus for testing dilution pipettes.—A large increase in the number of dilution pipettes submitted for test made it necessary to develop a more rapid method of test than that formerly in use. The new method has already proven highly satisfactory in both speed and accuracy.

Physical properties of baked products.—Last September the United States Manufacturers of Cream of Tartar (Inc.) placed a research associate at the bureau for the purpose of investigating the physical properties of baked products. Attention has thus far been given largely to a study of volume, because of the wide use of this property in evaluating flour, baking powder, and other ingredients of baked products. A detailed study has been made of the various methods used in the determination of volume, and many of the sources of uncertainty in previous measurements have been discovered and eliminated. The work is being continued and other properties, such as color and texture, will be studied.

Temperature of drying rolls.—The bureau was requested by the United States District Court of New York to determine the temperature of milk drying rolls, under conditions of use, as the temperature was an issue in patent litigation. A satisfactory method of making such measurements was found and applied.

Construction of instruments and apparatus and preparation of test specimens.—The construction division took care of the requirements for instruments and apparatus, including glass apparatus of various designs, and woodwork required in the upkeep of buildings. Test specimens and standard steel and alloy samples were also prepared. Some of the apparatus built may be mentioned: Three vibration galvanometers, stroboscope, amplifier set, six resistance frames, double spectrometer, optical head for coincidence type thread gage, two quadrant resolution instruments, autographic thermal expansion furnace, eight resistance standards, two diffuse illumination color comparators, and a large amount of special radio apparatus.

EQUIPMENT (\$88,000)

Upkeep of mechanical plant.—The usual maintenance work, such as the replacement of piping, fittings, valves, etc., has been carried on. A number of changes have been made in piping layouts to facilitate connection to the new power plant.

Electrical construction and repair.—The usual maintenance work on the electrical installations has been carried on and a great number of new electrical installations incident to laboratory expansion have been made.

Plumbing and pipe work.—In addition to the maintenance work on existing pipe systems, new extensions to steam, water, gas, air, and vacuum lines were made incident to the installation of new laboratory equipment. A new water main has been installed to supplement the water supply.

Spectrograph.—A quartz spectrograph, giving a spectrum from 2100 Å to 8000 Å, about 200 mm. long, was purchased for use in the spectroscopic section.

Timepieces.—A Shortt mean-time astronomical clock with slave clock, and a weight-driven printing chronograph with an error not exceeding one 1/100 second, were ordered for the mechanics and sound division.

Testing machines.—One hydraulic compression testing machine with a capacity of 300,000 pounds and an Amsler rope-testing machine were ordered for use in the testing of structural materials.

Machine tools.—Purchases for the bureau's instrument and machine shops included three plain precision bench lathes, one motor-driven shaper, and one universal milling machine, the last for use in the Chicago master-scale depot.

Miscellaneous machinery.—Purchases of other machinery included three vacuum condensate return pumps, one 100-kw. frequency changer set for use with high-frequency furnace, one air-conditioning unit for the cement section, and one 4-stage belt-driven hydrogen compressor for the low-temperature laboratory.

GENERAL EXPENSES (\$69,855)

Heat, light, and power.—Coal for heating and electricity for lighting and power purposes have been purchased as necessary.

Miscellaneous supplies.—Office and janitorial supplies, gasoline, and lubricating oil have been provided as usual.

Library books.—The number of volumes accessioned was 1,639 (the same as last year) and 201 were canceled, making the total number of accessioned volumes 33,871. Scientific and technical periodicals received number 1,056.

Travel.—Provision was made for travel on general bureau business, not connected with any specific problem. Travel of the members of the bureau's visiting committee was also provided for.

IMPROVEMENT AND CARE OF GROUNDS (\$14,431)

Improvement of grounds.—Good progress has been made in improvement of the grounds by grading and sodding, the planting of trees and shrubs, extension of sidewalks, construction of road curbing, etc.

TESTING STRUCTURAL MATERIALS (\$267,058)

Plumbing codes.—A revised edition of the report of the subcommittee on plumbing codes of the building code committee was published. These recommendations have been utilized in laws or regulations of seven States and more than 100 cities.

Building codes.—The building code committee practically completed its report on fire-resistive construction, and started to revise and consolidate the seven reports issued since 1923.

City planning and zoning.—Surveys of zoning ordinances and city planning activities throughout the country were made and issued. A standard city planning enabling act was published, and the standard State zoning enabling act has now been used in the laws of 34 States.

Construction economics.—A review of construction from 1919 to 1928 was written for the committee on recent economic changes of the President's Conference on Unemployment. The article on Construction for the Commerce Yearbook, and numerous other reports on building activity, building costs, and building materials, were prepared. Retail prices for building material in 55 cities have been issued monthly.

Home financing.—Present Home Financing Methods, a pamphlet for prospective home builders and groups interested in improving existing financing facilities, was printed.

Survey of small house construction.—Data on the design, choice of materials, structural details, and general conditions relating to the construction and sale of small houses were obtained through a field survey in 31 cities.

Cooperation with other agencies on building and housing problems.—Cooperation was continued with Federal and State agencies and with thousands of local governments and private organizations concerned with building and housing. City planning and zoning, building codes, and home-ownership problems were taken up jointly with bodies such as Better Homes in America with its 5,700 local committees and organizations representing architects, engineers, business, civic, and other groups.

Arlington Memorial Bridge.—In conjunction with the Arlington Memorial Bridge Commission, measurements of temperature, during and subsequent to the hardening of the concrete; deformations of the arch barrel due to changes in loading and temperature; rotations of the piers; and effectiveness of the expansion joints are being made in one of the reinforced concrete arch spans of this bridge. Both the elastic and inelastic deformations are being determined and the measurements are planned to furnish a check on the reliability of the results of model tests.

Durability of concrete aggregates.—Apparently there is no relation between strength of concrete and amount of disintegration. In several cases concrete made from aggregates which have been submitted to the sodium-sulphate and sodium-chloride treatments showed at 15 months no gain in strength or a loss of strength compared to the 3-month tests. In the boil and dry and untreated aggregates there was in every case an increase in strength.

Diatomaceous earth.—Fourteen samples of diatomaceous earth submitted by different producers were included in an investigation to study differences in these materials when used as admixtures in concrete. All were found to act in much the same manner, requiring

more water to give the same flow as concrete without admixtures. The strength was in some cases slightly lowered.

Durability of bond between mortar and brick.—Cooperating with the American Face Brick Association, an investigation of the durability of the bond between mortar and brick has been started. This work includes tests to determine the effects of absorption and rate of absorption of the brick, moisture content of brick when bonded, and initial curing conditions on the durability of the bond after a few months exposure to dry, saturated, or outdoor storage, or to 50 cycles of freezing and thawing.

Clay brick and brick masonry.—In cooperation with the Common Brick Manufacturers' Association, the effects on wall strengths of such factors as the physical properties of the brick, composition and properties of the mortar, and the workmanship have been determined for a wide range of the commercially important types of construction and materials. In addition, the strength and absorptive properties of brick from a number of sources have been determined to obtain data useful in the development of specifications for brick.

Cast stone.—Samples of cast stone from all parts of the United States show a considerable range in properties. The number of cycles of freezing and thawing that the specimens underwent before any signs of disintegration varied from 15 to over 500.

Slate.—Approximately 2,800 tests on about 60 samples of slate from quarries in Maine, Vermont, New York, Pennsylvania, Maryland, Georgia, Tennessee, and Arkansas gave the following values:

	Highest	Lowest	Average
Absorption by weight (per cent).....	1.63	0.1	0.27
True specific gravity.....	2.90	2.77	2.78
Bulk specific gravity.....	2.87	2.74	2.76
Modulus of rupture.....	16,160	3,380	9,340
Modulus of elasticity.....	18,400,000	7,400,000	13,400,000
Maximum deflection for $\frac{3}{16}$ inch thickness, 15.5-inch span (inch).....	0.240	0.081	0.145
Abrasive hardness.....	15.2	6.2	8.3

Frost-action tests on 23 samples of slate are in progress, some of which have undergone nearly 4,000 freezings. These tests indicate that slate has a high resistance to frost action.

Lime.—The compilation of data on the composition, fineness, and available lime content of chemical quicklimes was completed. Progress has been made in the development of an improved method for determining the soundness of lime. The present standard method requires at least three days for a test while the improved method takes from four to five hours. A continuous sedimentation method for determining the fineness of lime is being tried and appears to be capable of giving the desired results.

Sand-lime brick.—Absorption, transverse strength, compressive strength flat, and compressive strength on edge of representative samples of sand-lime bricks from 27 manufacturers have been determined. Some of the brick from each lot have been reserved for a more thorough study of the absorption characteristics, after which accelerated weathering tests will be made.

Gypsum fiber concrete.—This material, mixed in the proportions used in practice, may be expected to have an ultimate compressive strength of from 450 to 1,300 pounds per square inch.

Lime and gypsum.—Results indicate that the modified Vicat apparatus is superior to the Southard viscosimeter, the present standard instrument for testing consistency of calcined gypsum. Committee C-11 of the American Society for Testing Materials has adopted the modified Vicat apparatus as their standard.

Tests indicate that Keene's cement to be of good quality should have a tensile strength of over 450 pounds per square inch. The time of set of the majority of the cements tested was between one and four hours.

Elastic pointing materials.—The exposure of 60 proprietary materials to the weather for nearly two years in the joints of coping stone has indicated a large percentage of failures. Discolorations of the limestone near the joints due to oil penetration were found to disappear after a few months and hence this feature could not be considered especially objectionable. The most common failure of the materials is due to shrinkage cracks. A few of the very plastic grades flowed from vertical joints, while others became hard and inelastic after a period of weathering.

Waterproofing compounds.—Considerable difference has been found in the effectiveness of commercial dampproofing and waterproofing compounds. After seven days' curing, concrete test specimens are subjected to a 20 pounds per square inch water pressure. The permeability as measured by the amount of water passing through the specimen is determined at all ages up to one year.

Stone preservatives.—A special study has been initiated to determine the value of stone preservatives in preventing decay under various conditions. Several instances of decay of stone in important buildings have forcefully shown the need for more information in this field, since some of the building stones which have heretofore been considered to be reasonably permanent have reached advanced stages of decay within 60 years.

Abrasive hardness.—Further improvements have been made on the abrasion-testing apparatus, and data have been obtained on marble, limestone, sandstone, granite, and slate, as follows:

	Ha values		
	Highest	Lowest	Average
Marble (142 tests).....	34.5	7.5	17.0
Serpentine (14 tests).....	97.6	12.9	42.3
Limestone (149 tests).....	24.9	1.0	9.8
Sandstone (12 tests).....	10.8	2.5	6.7
Granite (30 tests).....	75.1	37.0	56.3
Slate (94 tests).....	15.2	5.8	8.1

The Ha figures given above were determined by abrading the various materials under uniform conditions with No. 60 artificial corundum and expressing the result as a reciprocal of the volume abraded in a given time.

Chemical testing and methods of analysis.—Approximately 2,000 samples of structural materials were tested for various branches of the Government. Analyses of Portland cement, cast irons, steels, alloy steels, ferro-alloys, brasses, bronzes, bearing metals, boiler plugs, Monel metal, and light aluminum alloys were made to aid in the

development of specifications, to insure proper delivery of materials, to detect causes of failure in service, and to determine the composition of materials used in metallurgical research. Nickel and chromium plated plumbing fixtures and hardware were examined, and some time was also spent in developing improved and more rapid test methods.

Cement reference laboratory.—In cooperation with the committee on cement of the American Society for Testing Materials there has been established a laboratory to deal with the various difficulties encountered in the testing of cement in the 300 cement laboratories of the country. Instruction will be given to employees of cement laboratories throughout the country in proper methods of testing, equipment used in testing will be calibrated, and new test methods will be studied. A staff has been assembled and the laboratory is now ready for operation.

Branch laboratories and inspection of cement.—The branch laboratories maintained at Northampton, Pa., for inspection and testing of cement; Denver, Colo., for testing of cement and concreting materials; and San Francisco, Calif., for testing cement and miscellaneous materials; together with the cement-testing laboratory in Washington, have rendered a much-needed service to Government purchasing agencies. One million two hundred and ninety thousand five hundred and forty-two barrels of cement were sampled and 1,073,590 barrels were shipped.

TESTING MACHINES (\$41,003)

Calibration of testing machines.—Specifications have been issued covering the manufacture and use of proving rings, of which 17, with capacities up to 100,000 pounds, have been tested. Proving rings which failed to meet the specifications have been studied to determine the cause of their unsatisfactory performance. Experience has shown that proving rings are superior to any other device on the market for calibrating testing machines.

Bridge towers.—At the request of the Port of New York Authority the bureau has undertaken a series of strength tests on models of the tower column sections used in the Hudson River suspension bridge. Four columns, 24 feet in length, with a section area of about 160 square inches, have been tested to destruction. Two were made from ordinary structural steel and two from silicon structural steel. The former failed at loads of about five and one-half million pounds and the latter at about eight and three-fourths million pounds. The column strengths and coupon test specimen values were found to agree very well. There was no indication of detail or secondary failure.

Fatigue of Alclad.—In cooperation with the Aluminum Co. of America the fatigue resistance of over 120 specimens of corroded and uncorroded Alclad and comparable duralumin sheets is being determined. Some of the specimens have been subjected to over 100,000,000 cycles of stress. The results indicate that the corroded Alclad specimens have approximately the same life as the uncorroded specimens and that the fatigue limit of the corroded duralumin specimens is slightly less than for uncorroded specimens.

Methods of locking screw threads.—An investigation of methods of locking screw threads is being actively prosecuted in cooperation with the Dardelet Threadlock Corporation and other manufacturers. Machines are now being built to apply repeated loads to either the

bolt or nut somewhat as they are applied in service. The stresses in the bolt will be measured by means of optical instruments. All manufacturers of thread-locking devices have been requested to cooperate.

Dome of the New National Museum.—To insure the safety of a jacking operation during repairs to the dome of the New National Museum the bureau laid out 96 gage lines on the steelwork which were measured with strain gages morning and evening during the 40 days required for the work. The total number of readings was about 4,000. It is believed that the stresses in the steelwork were determined with an error not greater than 500 pounds per square inch.

Copper roofing.—Tests in cooperation with the Copper and Brass Research Association show that the maximum load which can be continuously supported by a soldered seam without eventual failure is about one-quarter of the breaking load found by the usual tensile test. Data have been obtained which will provide the basis for formulas for computing the sizes of gutters required on buildings. An investigation of a form of localized corrosion affecting open-valley flashings has been completed. An inexpensive change in the method of laying the flashing is suggested as a means for eliminating corrosion difficulties.

INVESTIGATION OF FIRE-RESISTING PROPERTIES (\$30,213)

Fire resistance of hollow load-bearing wall tile.—The main series of tests in cooperation with the Hollow Building Tile Association consisted of 167 fire-endurance tests and 4 fire and water tests of typical wall constructions, 71 of which were made with walls between 10 and 11 feet high and 8 to 16 feet wide. This was preceded by two preliminary series to determine the effects of fire on individual tile units, the effects of changes in design of unit, and in the constituents and preparation of the clay.

The results are summarized as fire-resistance periods, which are determined by the time the walls sustained load under fire exposure and prevented the average temperature rise on the unexposed side from exceeding 139° C. (250° F.), or the maximum rise at any point where temperature measurements are taken from exceeding 180.6° C. (325° F.). Freedom from cracks or openings large enough to transmit flame or ignite combustible materials is also required both in fire-endurance tests and fire and water tests.

The final grouping of test results is in three classes, determined by the design of the tile. Fire-resistance periods are given for 8, 12, and 16 inch walls in each class, the values varying with the thickness and design from 1¾ to 11 hours for unplastered walls and from 4 to 15 hours for walls plastered on both sides. Periods for walls assumed to have combustible members projecting into them 4 inches from the unexposed side ranged from 1 hour with 8-inch unplastered walls to 10 hours with 16-inch plastered walls built of tile of the designs giving the highest results.

Severity of building fires.—A burning-out test was conducted in a fire-resistive building containing kerosene in open pans to an amount giving approximately the same Btu content as was present in the furniture and paper in a previous similar test with office occupancy. Although, on account of its higher fuel value, the weight of kerosene introduced was less than one-half of that of the wood and paper for

the companion test, the equivalent duration of the resulting fire was the same within 10 minutes. The results indicate possibility of gaging the fire hazard of occupancies in terms of the severity of the standard furnace test by means of the amount and fuel value of combustibles present per unit of floor area or room volume.

Moving of large wall furnace.—As provided for by a special appropriation of \$22,000, the structural framing of the large wall furnace and shelter has been moved to a new location and reerected with reinforced concrete inclosing walls and roof. The new furnace is designed to obtain good temperature uniformity over the wall area exposed, and a fire control that will enable the furnace exposure to be duplicated in successive tests and conform with prescribed standards.

INVESTIGATION OF PUBLIC UTILITY STANDARDS (\$107,297)

Electrical codes.—A new edition of Handbook 4, discussion of the National Electrical Safety Code, was issued, and a pictorial edition of this code is in preparation. Assistance was given State commissions in Nevada and Wisconsin in preparing State codes. A 1929 edition of the electrical code combining accident-prevention and fire-prevention rules was prepared, and cooperation was rendered in the preparation of a standard code for the use of electricity in metal mining. The bureau assisted in the revision of the National Electrical Code of the National Board of Fire Underwriters for a 1929 edition.

Protection against lightning.—Miscellaneous Publication No. 92, Code for Protection Against Lightning, was issued. Data collected by the Western Actuarial Bureau were analyzed. Assistance was given in the preparation of the report on protection against lightning of the National Fire Protection Association.

Code for electricity meters.—The new edition of the Code for Electricity Meters, issued under a joint sponsorship of the National Electric Light Association, the Association of Edison Illuminating Companies, and the bureau, has been submitted to the United States national committee of the International Electrotechnical Commission as a proposed basis for an international specification for alternating-current watt-hour meters.

Surveys of Government telephone service.—Methods of meeting the telephone service requirements of activities both in Washington and in the field have been studied. Recommendations were made for a consolidated Treasury system in Washington on completion of the Internal Revenue Building and concerning consolidated service in nine Federal buildings in other cities.

Soil-corrosion investigation.—Approximately 1,000 samples of pipe materials were removed from the soil-corrosion test locations and examined. The results confirm those previously published. An extensive investigation of protective coatings for pipe lines is under way.

Measurement of high voltages and large currents.—The optical parts for the large high-voltage electrometer were completed. The guard condenser was assembled and studies of its potential distribution were made. The original beam-arrestment mechanism was discarded and a much more accurate mechanism was designed and constructed. Oil-cooled shunts for 1,000, 2,000, and 2,500 amperes were finished,

with the necessary oil-cooling equipment, and a standard current transformer for currents up to 12,000 amperes was nearly finished. A cathode-ray oscillograph for use in studying the properties of liquid dielectrics was completed.

Fractional distillation of gases.—Study of methods for the analytical separation of natural gases by fractional distillation, including the definition and determination of the gasoline in the gas, was completed.

Specific gravity and density balances for gas.—An improved balance was constructed employing a type of suspension not previously used in this field. A balance has also been designed for the direct determination of the density of gases.

Oven linings.—The corrosion of the majority of available commercial oven linings under service conditions has been determined.

Miscellaneous gas appliances.—The efficiency of storage water heaters has been measured, methods of rating them worked out, and satisfactory performance standards recommended. A study was made of the floor temperatures under radiant heaters with reference to standard tests for safety in connection with such heaters.

Burners for propane and butane.—Successful laboratory burners for these "bottled" gases were constructed and are now being used as models by apparatus companies.

TESTING MISCELLANEOUS MATERIALS (\$47,125)

Variety of materials tested.—A great variety of chemical and physical tests were made for Government departments on paints, varnishes, roofing and waterproofing materials, rubber goods, packings, inks, typewriter ribbons, carbon paper, textiles, boiler waters and compounds, detergents, chemicals, gold alloys, etc. Miscellaneous materials were tested to determine their fire hazard to guide the Steamboat Inspection Service in making rulings on the transportation of commodities on passenger vessels.

RADIO RESEARCH (\$55,772)

Standards of radio-frequency.—The accuracy of the bureau's frequency standard was considerably improved by means of piezo-oscillators, in which special attention was paid to temperature control and quartz plate mountings. The error in constancy of these piezo-oscillators is less than 5 parts per 1,000,000. Intercomparisons between the bureau's standards and those of two other laboratories in the United States showed agreement to 1 part per 100,000. The transmitters used for sending out scheduled signals of standard frequency were reconstructed in order to permit closer frequency setting and control, with resulting marked improvement in the accuracy of the transmissions.

Study of piezo-electricity.—A theoretical and experimental study of the operation of the quartz plate in a piezooscillator was made. The modes of vibration of a quartz plate were studied by observing the glow discharge surrounding the plate when operating in helium at a low pressure. Special methods of driving the quartz plate in a piezooscillator were developed and studied.

Improvements in testing station frequency standards.—The accuracy of testing piezooscillators used by broadcasting stations was in-

creased about ten times by using a method which gives a calibration directly in terms of a standard piezooscillator. The temperature of the room used for testing is maintained constant at all times.

Radio wave phenomena.—The vagaries of radio wave transmission were studied by means of field intensity measurements, fading records, and wave direction determination. Measurements were made at the bureau, at field stations, and in a traveling laboratory. Rapid variations in the intensity of received signals were found to be partly due to continual changes in the plane of polarization of the waves which arrive by way of various paths and combine at the receiving station. Apparatus was developed to isolate the various factors involved and to make possible a study of each one independently. Measurements were made on the apparent height of the Kennelly-Heaviside layer by measuring the time difference between the arrival of the ground wave and the upper-air wave.

Radio wave propagation.—Continuous signal intensity records from long-wave stations in various parts of the world are furnishing information as to annual, seasonal, and diurnal variations in signal strength and as to the properties of the Kennelly-Heaviside layer which causes fading of signals, errors in direction finding, and other variations in radio propagation.

Correlation of radio with other natural phenomena.—When averaged over long periods, daylight signal intensity appears to vary directly while daylight static varies inversely with solar activity and the disturbances in terrestrial magnetism. Correlations with weather are very marked in the case of static and less marked in the case of signal strength.

Assistance to Federal Radio Commission.—Technical assistance, including preparation of data, was given the Federal Radio Commission. At the request of the commission the services of the chief of the radio section were made available for a period of four months, during which he served as chief engineer and organized the engineering division of the commission.

COLOR STANDARDIZATION (\$10,950)

Fixing upon a standard "white."—The spectrum colors, such as red and green, are specified by their wave length, but white must be fixed by agreement. Various suggestions are as yet open to selection: "White" shall be defined as the color (*a*) which a sufficient number of observers, having normal color vision, select by preference; or (*b*) of the sun's radiation (outside the atmosphere); or (*c*) of a completely overcast sky; or (*d*) of an equal energy spectrum; or (*e*) of a "black" body when the ratio of its luminosity to its total radiation is a maximum, about 0.14.

Of these, (*b*), (*c*), and (*e*) have been the subject of intensive study which, it is believed, will soon culminate in a generally acceptable specification for white.

Spectrophotometric measurements fundamental to the photometry of practical light sources.—Color differences between various light sources in common use entail a direct comparison of intensities. Calibrated optical filters for equalizing the color have proved effective.

From a recent interlaboratory comparison in this country of several such filters it was concluded that: (1) Consistent values may be obtained by the spectrophotometric method in the measure-

ment of the intensities of deeply colored light; and (2) such values agree more or less satisfactorily with the averages obtained by the so-called flicker and equality-of-brightness methods of photometry.

Blue filters are now being evaluated by the national laboratories of England, France, Germany, and the United States, by means of which the relative efficiencies of vacuum and gas-filled lamps may be expressed on a common basis in all four countries.

Lovibond glasses.—The calibration of 65 of the "35-yellow" Lovibond glasses, used in the color grading of edible oils, which has been conducted in cooperation with the American Oil Chemists' Society, was completed and a publication issued. The effect of temperature changes on the readings with red and yellow glasses was also determined and was found to be small. More than 1,000 red glasses have been calibrated in terms of the bureau's standards and reported to the owners. The results of these calibrations are now being collated and prepared for publication.

INVESTIGATION OF CLAY PRODUCTS (\$49,370)

Investigations on architectural terra cotta.—In cooperation with the National Terra Cotta Society the resistance of terra cotta to weathering was determined. Factory tests are being developed to assist terracotta plants in inspecting their ware before it leaves the factory.

The best method of setting terra-cotta ashlar on buildings was studied. Filled terra-cotta facing adds considerably to the strength of walls and apparently justifies reckoning filled terra cotta as a portion of the thickness of walls.

In brick-backed construction, if mortars are improperly used, the expansion of the brick masonry tends to pull apart the terra-cotta ashlar and thus open the terra-cotta joints. This expansion is capable of producing a considerable pressure on the terra-cotta facing unless expansion joints are provided.

Refractory bricks and clays.—Test data obtained on 27 fire clays and 14 brands of fire-clay bricks indicate that the temperature of firing of these materials has a decided influence on their physical properties, which in turn affect the life of the refractory when subjected to thermal shock. Preliminary recommendations have been made as to desirable properties for saggers to increase their life.

Resistance to abrasion of metals, suitable for dies, to the flow of plastic clay.—A marked difference has been found in the wearing qualities of different metals. For example, it was found that for the same length of clay column extruded the losses by abrasion of carbon-chrome steel and cast iron (both widely used in the industry) were as 1 to 12.

Investigation of hollow-ware dies.—Density of the clay column is affected more by slight changes in the ratio of water to dry clay—that is, from 1 to 2 per cent—than by a change of 25 per cent in die length or 50 per cent change in die taper. Die lubrication plays an unimportant part in reducing the power consumption, but materially improves the column by preventing torn corners and developing smoother surfaces generally. The most efficient hollow-ware dies for medium plastic clays are those having tapers less than 6° and a total length of not over 3 inches or less than 2 inches and cores not over 1½ inches or less than 1 inch in length.

Application of light-colored vitreous first coats to sheet iron and steel.—The following procedure for applying a light-colored vitreous enamel directly to sheet iron or steel was developed:

The metal is first prepared for enameling in the usual manner. It is then dipped in a 4 per cent solution of cobalt nitrate at about 95° C. and allowed to remain until hot. Upon withdrawal, the hot metal quickly dries, after which it is placed in a furnace at about 300° C. for five minutes, when the cobalt nitrate apparently decomposes and the metal simultaneously acquires a coating of its own oxide and of cobalt oxide. Both of these oxides when at the surface promote adhesiveness, and it appears that practically any enamel composition which is satisfactory in other respects will adhere well when the iron is prepared in this way.

Cast iron for enameling purposes.—The gas which causes blisters in an enamel when applied to some iron castings appears to be principally CO₂, with some CO admixed. This evolution of gas may occur without damage at certain stages of the enameling process, but from a blistering iron continues through the critical stage of the enameling during which the relatively thick finish coat of enamel is fused and too viscous to permit free escape of the gas. The evolution of gas during the critical period appears to be caused by the breakdown of combined carbon and its recombination with oxygen, and is controlled by the amount and condition of the combined carbon present in the surface of the casting to which the enamel is applied. Experiments have shown that it is possible to modify the nature of this surface layer so as greatly to reduce blistering through the addition of certain elements to the iron, notably silicon, which diminishes the proportion of combined carbon.

Use of feldspar in white ware.—Ten similar vitreous white-ware bodies, maturing at cone 14, were prepared and their properties determined. The kind of feldspar used and the calcination of different components appear to have very little effect on the physical properties, except in cases where the feldspar evidently lost its fluxing power in calcination.

Crazing of semiporcelain dinnerware.—Thermal expansion was measured on pieces of plates as received and on pieces of the same plates after they had been treated in the autoclave. The first expansion of each piece after it had been given the autoclave treatment was lower than its expansion before, thus showing that the ware had absorbed some water during treatment. There was also a material increase in weight. Specimens with a high water absorption, with two exceptions, crazed during the autoclave treatment.

Improved apparatus for testing chinaware.—A modified pendulum apparatus, using one 5-ounce hammer, for testing the resistance of chinaware to impact and chipping has been designed and built to obviate difficulties encountered in the use of the apparatus specified in United States Government Master Specification for Vitrified Chinaware, No. 243a.

Columbus laboratory.—At the Columbus branch there were secured during the year data showing the elasticity and thermal dilation of about 110 white-ware glazes. This work was undertaken to secure factors which might enable one to calculate these physical properties from the composition of the glazes. The 17 representative English china clays are being studied for use in the white-ware industry.

The data will be compared with representative china clays of domestic origin. The cooperation with the American Society of Mechanical Engineers on the study of power-house refractories was continued with satisfactory results. Studies of a special white-ware body in which fluxes are being introduced indicate the possibility of lowering maturing temperatures for certain types of white ware. The study of 26 representative alluvial and glacial clays and shales to determine the characteristics which indicate their usability was well advanced.

STANDARDIZING MECHANICAL APPLIANCES (\$29,677)

Testing of engineering instruments.—The volume of work in the calibration of water current meters and other engineering instruments has increased by 40 per cent in the past fiscal year and by over 100 per cent in the past three years.

Fire-extinguishing appliances.—The testing and investigation of fire-protection appliances for the Steamboat Inspection Service has been extended to include certain types of complete extinguishing systems for ships, as distinguished from portable apparatus. Construction and performance specifications were drawn up for portable extinguishers of the foam type.

Performance specification for numbering machines.—The experimental study of the durability of numbering machines, resulting in the formulation of a performance specification for machines of the lever type for the use of the Federal Specifications Board, has been extended at the request of the Post Office Department to develop performance specifications for other types of numbering machines.

Automatic postal machines.—The bureau has cooperated with the Post Office Department in studying the possible extension of the use of time and labor saving automatic postal machinery.

Elevator safety interlocks.—Additional commercial examples of interlocks have been tested. The data are made available, as a basis for their approval for use on installations in their respective jurisdictions, to certain regulatory bodies, as, for example, the Government departments, State governments, and casualty insurance companies.

Accelerometer testing equipment.—Equipment for testing accelerometers has been designed and constructed. This consists of a rotating disk with provision for photographing the dial of an instrument under test when a reading is desired.

INVESTIGATION OF OPTICAL GLASS (\$27,420)

Production of optical glass.—Thirty-nine pots of six different kinds of optical glass, borosilicate crown, barium flint, medium flint, dense flint, light barium crown, and ordinary crown, were made to determine melting procedure which will consistently yield glass of good quality.

Blanks numbering 25,910 and weighing approximately 3,500 pounds were molded and annealed, the majority being used by the Navy Department.

Physical properties of glass as affected by thermal treatment (including annealing).—Additional values for the increases in refractivity and density per degree centigrade decrease in the effective annealing temperature, and a slight revision of some of the values previously reported have resulted from new data. Some of the more reliable tentative values are:

Type of glass	Increase in refractivity and density per degree centigrade decrease in effective annealing temperature.		Range of effective annealing temperature for which values were determined (° C.)
	Refractivity	Density	
Medium flint.....	0.000024	0.00016	350-460
Dense flint.....	.000036	.00027	360-440
Borosilicate crown.....	.000048	.00028	470-540
Ordinary crown.....	.000032	.00017	500-570
Light barium crown.....	.000047	.00033	500-570

Viscosity of glass.—It has been found that the viscosity-temperature relations of light barium crown and borosilicate crown glasses can be expressed by the equation:

$$\text{Log. } \mu = C - \frac{A}{B} \sqrt{b^2 - (1,400 - T^2)}$$

in which μ = viscosity, T = temperature (° C.), and A , B , and C are constants having the following values for the two types of glasses: Borosilicate crown, $A=8.53$, $B=700$, $C=10.53$, and light barium crown, $A=8.22$, $B=600$, $C=10.18$.

Relations between chemical composition, density, and index of refraction of glasses.—A series of glasses was made by melting mixtures of pure silica and soda ash in a specially designed platinum resistance furnace. The composition of these glasses varied from approximately 50 per cent silica, 50 per cent soda to 80 per cent silica, 20 per cent soda.

The density of these glasses can be quite accurately computed from the expression:

$$D = 0.3293 (P_a - 30)^{0.4486} + 0.01873 (P_b)^{1.0802}$$

in which P_a and P_b are the percentages of silica and soda, respectively.

The work on index of refraction necessitated a modification of the method of measurement because some of these glasses are too hygroscopic to permit grinding and polishing in the ordinary way.

INVESTIGATION OF TEXTILES, ETC. (\$54,144)

Method for testing yarns.—An improved multiple strand method for testing yarns has been devised, in which 100 or more lengths arranged parallel to one another under the same tension may be broken simultaneously, thus giving average results for a considerable amount of material. Auxiliary equipment has been built which permits testing with the yarns wet with any liquid and at any temperature, thus simulating conditions existing during the process of manufacture, laundering, or cleaning.

Wool meter.—A simple portable instrument for grading raw wool has been devised. Results obtained with it agree to better than 2 microns with laborious, time-consuming, microscopical measurements.

Properties of parachute fabrics.—A study of the properties of silk parachute fabrics, for the National Advisory Committee for Aeronautics, shows that parachute silk of American manufacture is equal to or better than imported cloth. Specifications for parachute fabric have been prepared.

Laundry "winter damage."—A type of laundry damage, prevalent in the New England States in the wintertime, known as winter damage, was investigated at the request of the Laundry Owners' National Association. It was found that a slight modification of the laundry procedure will materially decrease this damage.

Dyes.—The fading of dyed textiles in sunlight transmitted by various glasses showed that the ultra-violet in sunlight which is not transmitted by window glass has relatively little fading action on most fabrics. The fastness to washing of dyed fabrics was studied, and a machine for making laboratory tests was built in cooperation with the American Association of Textile Chemists and Colorists which has adopted it as a standard for the association. The spectral reflection of dyeings was studied with reference to the dyeing process.

Postage stamps.—Cooperative work with the Bureau of Engraving and Printing on United States postage stamps was undertaken at the request of the Secretary of the Treasury, to effect any possible improvements in the manufacturing processes or in the quality of the stamps. One complete printing, gumming, and drying unit is being used for experimental purposes, and thorough laboratory tests are being made of the raw materials and the finished product.

Paper Currency.—A publication was prepared which describes further developments in the manufacture of currency paper, including the use of various combinations of linen and cotton fibers, and the effect of variations in the cooking, bleaching, beating, and sizing operations.

Paper quality standards.—Chemical and physical tests, including accelerated aging tests, of representative commercial writing and book papers are being made. One of the important indications of the tests is that the processing of the fiber, irrespective of its source, is the most important factor in its rate of deterioration.

Paper-testing methods.—A recommended procedure for determining the bulk of paper was developed. Modifications in the design of bursting strength testers were suggested to assist in overcoming some of the variables of such instruments. The cooperative work with the Technical Association of the Pulp and Paper Industry on development of official association test methods resulted in the completion of methods for gloss, opacity, and bulk.

Miscellaneous.—Experiments have been conducted on a humidity-recording instrument for use in paper laboratories, on methods of measuring gloss and brittleness, and on several unusual papers and paper-making fibers. The use of sawdust and waste papers has been found feasible in the manufacture of roofing felts. On the other hand, rayon, which is commonly found to some extent in paper-making rags, was found to have no paper-making value. Some investigations have been made on building board from compressed wood, flax from New Zealand, insulating board from licorice root, and a very strong paper made from mitsumata fiber, submitted by the Imperial Government Printing Bureau of Japan.

SUGAR STANDARDIZATION (\$58,227)

Hard refined levulose production.—The semifactory-scale plant is practically completed. The problem of washing the artichoke tubers and removing foreign material has been successfully solved, and the hydraulic press station has been improved.

About 10 tons of cleaned artichokes were worked and the juice concentrated for dilution later in the experimental operation of the plant. Further study of the 8 per cent of substance which does not convert to levulose revealed the presence of a group of new disaccharides, one of which has been recovered in crystalline form. This sugar is composed of two molecules of levulose and has been named difructose anhydride. As no system of analysis of products containing levulose is in existence, the bureau has carried forward the development of such a system to the point where it is now available for plant control.

Color research in sugar production.—The transparency and optical stability of sugar solutions for spectrophotometric analysis have been studied, and the methods for obtaining them have been improved and the time of preparation reduced. A method of preparing the asbestos fiber used for the filtration has been worked out so that only two hours are required for a step which formerly required several days.

Testing of sugars.—The testing of sugars and sugar products, as well as of polarimetric equipment used in pure research and in the industries, was continued on an augmented scale. The scientific supervision of the collection of the duty imposed by the tariff act on sugars, molasses, etc., vested in the bureau, has been continued by means of daily exchange samples of sugar and molasses. In response to industrial requests a table of weights per gallon of sugar solution at the standard temperature of 20° C. has been developed and a supplementary table of weights per gallon at different temperatures computed.

GAGE STANDARDIZATION (\$40,713)

Measurement and certification of master gages.—There has been a considerable increase in the number of gages submitted for test. The largest volume of work has been submitted by the petroleum oil industry which has sent master gages for well-casing threads, rotary tool joints, rotary drill pipe, line pipe, and sucker-rod gages. An increasing number of gages have also been submitted by manufacturers of machine tools and automobile accessories.

Cooperation with standardizing bodies.—The bureau has cooperated with the National Screw Thread Commission in carrying out researches on the strength of screw threads and in preparing and editing the 1928 report of the commission; with the American Gage Design Committee in preparing standard designs for gage blanks; with the American Petroleum Institute in fixing tolerances for master gages and products used in the production of petroleum oil; and with the Diamond Core Drilling Manufacturers Association in standardizing equipment used in diamond core drilling operations.

New and improved methods have been devised and utilized in the measurement of gages. Particular attention has been given to the setting up of standard conditions and equipment for the measurement of screw-thread gages.

Standard method of determining pitch diameter of thread gages.—Disputes frequently have arisen between gage maker and the purchaser and user of thread plug gages with regard to values of pitch diameter of the thread obtained by the wire method of measurement. This method is almost universally used and its intrinsic accuracy is satisfactory from a practical viewpoint. While a difference in the value for pitch diameter may be due to inaccurate wires or measuring

instruments such differences may arise from variations in the method of determining the diameter of the wires or the use of widely different or excessive contact pressures. The bureau, after consulting with some of the gage makers, has adopted definite limits for contact pressures and a standard method for determining diameter of the wires used. These standard methods together with specifications for measuring wires have been adopted by the National Screw Thread Commission.

INVESTIGATION OF MINE SCALES AND CARS (\$13,688)

Tests of mine scales.—The mine scale test equipment of the bureau made tests of 153 mine scales in the eastern coal fields. Fifty scales, or 32.7 per cent, were within tolerance, while 103, or 67.3 per cent, were found to be incorrect.

The general results, in comparison with results of other years, show no appreciable changes which might be interpreted to indicate consistent betterment of weighing conditions at coal mines. In sections of the eastern coal regions, since recent dissolution of previously existing labor agreements, a noticeable trend toward the system of payment by contract or by car is apparent.

METALLURGICAL RESEARCH (\$51,614)

Foundry sands.—In cooperation with various rubber companies and with foundries a study has been made of special rubber cements and of rubber latex as a binder for foundry core sand. Such binders give cores of high permeability which allow the use of fine sand and consequent smooth finish on the cored surfaces. The cores burn to loose sand, which is extremely easy to remove from the casting, thus greatly reducing difficulties in cleaning out the cores. Core strengths equivalent to those obtained with linseed oil core binders can be reached with the rubber-bonded cores.

Foundry practice.—Work in cooperation with the Steel Castings Development Bureau, and with the Bureau of Mines, on causes for low ductility in steel castings continues.

In cooperation with the American Foundrymen's Association a study has been started of methods for determining the shrinkage of metals and alloys during freezing; that is, on the propensity to give unsound castings because of internal shrinkage. Methods of determining the fluidity of metals—that is, their ability to fill a mold during casting—are likewise being investigated.

Rail steel.—The endurance properties of steel from rails taken from track after service have been compared with those of steel from rails from the same ingot before service. The endurance properties of steel from rails that have failed by transverse fissures have also been studied. Fissures apparently arise from tiny cracks present in the rail before service. Further work on endurance properties of failed rails and of alloy and heat-treated rails is in progress, as is work on the relation between endurance values determined by axial loading instead of in rotary bending.

Active work on the properties of rail steel at high temperatures is being continued. A large proportion of the rail steel examined has a range of brittleness at high temperatures, in which the steel is both weak and of low ductility. While it is not yet certain that cooling stresses exerted as the rail passes through this temperature range are

responsible for the "shatter cracks" that appear to be the nuclei responsible for transverse fissures, there is enough evidence that the cracks have some thermal source to justify much further work along this line.

High-speed tool steel and the machinability of steel.—A report on a new method of evaluating the ability of tool steels to take light cuts (finish turning), and on the effect of nickel, cobalt, arsenic, antimony, copper, tin, aluminum, titanium, or tantalum in high-speed steel, both in roughing and finishing cuts, is in press. A study of the behavior of tungsten carbide tools has been started.

Bearing bronzes.—The effect of zinc as impurity of copper-tin-lead bearing bronzes for automotive use has been studied in cooperation with a research associate from a manufacturer of bearings, and a paper describing the work is in press. Zinc is by no means as harmful as is often supposed. Work on the effect of nickel, antimony, and phosphorus in these bearing bronzes is in progress.

Substitutes for platinum.—The working of pure rhodium, and of alloys of platinum and rhodium high in rhodium has been successfully accomplished, and these alloys are showing up well in service as furnace windings. Information on the properties of alloys and on their utility as cheaper substitutes for pure platinum and other platinum alloys is nearly ready for publication. Work is in progress on the quality of various platinum alloys for laboratory crucibles.

Corrosion of metals.—Results of a study of laboratory corrosion test methods for zinc-coated steels have been published, and a paper on the effect of aeration in electrolytic corrosion testing is in press. Apparatus for the study of the effect of aeration in submerged corrosion testing is in operation. The study of corrosion of nonferrous screen wire cloth and corrosion of zinc-coated products when exposed to the weather has been continued in cooperation with the American Society for Testing Materials.

Specifications.—The usual cooperation has been given to the Federal Specifications Board and to technical societies in preparation of specifications for metals, metallic products, molding and core sands, and foundry supplies.

HIGH-TEMPERATURE INVESTIGATION (\$10,401)

Comparison of older temperature scales.—After the adoption of the international temperature scale a comparison was made between the thermoelectric portion of this scale and the three other thermoelectric scales which had been used by the bureau since 1912. None of the older scales differed from the international scale by more than 0.3°C . The freezing point of copper on the international scale was determined as $1,083.0^{\circ}\text{C}$. and that of the copper-silver eutectic as 779.4°C .

Thermoelectric properties of platinum-rhodium alloys.—The emf against platinum of a series of these alloys with rhodium content from 1 to 100 per cent was determined over the range 0° to $1,200^{\circ}\text{C}$.

Freezing point of nickel.—The location of this point makes it a very convenient one for the calibration of the standard optical pyrometer. The temperature was found to be constant and reproducible, the average found for each of two separate lots being $1,454.9^{\circ}\text{C}$., which when rounded to $1,455^{\circ}\text{C}$. is believed not to be in error by more than 1°C .

SOUND INVESTIGATION (\$11,469)

Acoustic properties of building materials.—The demands upon the new reverberation chamber for measuring the sound absorption of materials used in the interior finish of auditoriums are already greater than can be promptly met. One reason for this is the development of the talking picture, which has suddenly directed attention to the acoustic quality of existing theaters which had been built with no consideration of this point. A large number of measurements have been made to develop a lime plaster that shall be a good absorber of sound. These experiments have given promising results but are not yet completed. Panels of stud and steel construction have been tested for their soundproof character. The soundproofing of airplane cabins has been studied and flight tests have been made with the cooperation of the Navy Department and of the Army Air Corps.

Tuning fork investigation.—The behavior of tuning forks made of materials other than steel has been studied to find some material which will produce a fork free from certain errors inherent in steel, especially the effect of amplitude of vibration upon frequency. Incidentally, it has been necessary to study somewhat extensively the effect of the character of the mounting upon the period of a tuning fork.

INDUSTRIAL RESEARCH (\$203,627)

Properties of water and steam.—In cooperation with the American Society of Mechanical Engineers, experiments yielding data on the heat capacity of water over the range 0° to 270° C. were completed. Observations were taken over intervals of 10° C. and values of the heat content or enthalpy of saturated water at 10° intervals have been obtained, each value being the result of nine or more complete determinations.

Representative values follow.

Temperature, °C.	Enthalpy Mean cal/gram	Temperature, °C.	Enthalpy Mean cal/gram
10	10.03	150	150.88
30	29.99	200	203.99
50	49.94	250	259.11
100	100.00	270	282.76

Experimental data on latent heat at 100°, 130°, 150°, and 200° have been obtained.

Properties of petroleum products.—In cooperation with the American Petroleum Institute, the correlation of existing data on important properties of these products has been completed and the experimental work is designed to furnish data now lacking. Measurements of the thermal expansion and compressibility of petroleum products over the range 0° to 300° C. and 1 to 50 atmospheres are in progress. A calorimeter for measuring specific and latent heats of petroleum products has been constructed, assembled, and tested.

Thermal conductivity of insulating materials.—A new apparatus for making measurements of conductivity at lower temperatures was built and used to make measurements on a number of typical insulating and building materials over the range of temperatures from -30° to +70° C. The conductivities increase with temperature at rates of 0.2 to 0.4 per cent per degree centigrade. Measurements of conductivity of loose fibrous materials showed that conductivity

increases as the packing becomes very loose. The conductivities of some of these materials, particularly asbestos fibers, are unexpectedly high. Comparison of conductivity tests by other laboratories by means of calibrated specimens showed average deviations of about 3 per cent, which is satisfactory for commercial purposes.

Efficiency of street car reduction gears.—Comparative tests have been made on two spur gears and one worm gear type in cooperation with the American Electric Railway Engineering Association, improved methods of testing and new equipment having been specially developed for the purpose.

Quenching media.—In hardening steel by quenching, in heat treatment, it is often desired to cool the steel at a rate intermediate between the rate obtained by quenching in water or aqueous solutions and by quenching in oil. The use of hot aqueous solutions, while it has some drawbacks, appears to solve the difficulty in at least some cases.

Metal spray.—The method of coating a metal or some material like wood or paper with another metal to produce a surface more resistant to moisture, or with other desirable properties, has drawbacks in that it is sometimes impracticable to roughen the surface which is to receive the coating so that it will adhere properly. There is a tendency for the coating to be porous. By the use of special rubber cements the adhesion can be much improved and the pores filled. Experimental specimens have been produced which have satisfactorily withstood severe corrosion or exposure tests in cooperating plants which have to combat corrosion of chemical vapors or liquids.

Gases in metals.—Work on the problem of determining the tiny amounts of oxygen, hydrogen, and nitrogen in iron and steel has been centered on overcoming some of the remaining difficulties in the analytical methods and a determination of their limitations. Both vacuum fusion and "residue" methods have been studied, the latter in close cooperation with the Bureau of Mines. A study of the ways in which nitrogen combines with iron has been completed.

Heat-resisting alloys.—Long-time tension ("flow" or "creep") tests on several alloys of industrial importance and similar tests on a series of alloys of nickel, chromium, and iron were made in cooperation with the joint committee on high temperature properties of metals of the American Society of Mechanical Engineers and the American Society for Testing Materials, as well as with a research associate from a manufacturer of alloy steels. These alloys are the foundation upon which most of the industrial alloys for service under extreme temperature conditions are built. Further work on these alloys, including a study of the effects of various other elements, is contemplated.

Wear-resisting alloys.—The wear resistance of chromium plating, applied under different conditions of deposition, and of the new nitrided steels has been studied, using the gage wear tester, previously developed at the bureau. A rather comprehensive study of a commercial wear tester made abroad, which uses sand as the abrasive, has not so far shown much promise in that method of testing, as it does not distinguish sharply between metals known to vary in wear resistance in actual service.

Health hazards in chromium plating.—In cooperation with the United States Public Health Service a study was made of the effects of chromic acid spray upon the health of the operators and the meth-

ods and degree of ventilation required to eliminate such hazards. The results showed that with reasonable precautions there is no serious hazard in this industry.

Thermal expansion.—The thermal expansion of magnesium and some of its alloys, as well as of tantalum, rhodium, and amber, have been determined. Determinations of the thermal expansion of chromium and fused quartz are now in progress.

Elastic hysteresis research.—Progress has been made in determining the source of the discrepancy in the values of the elastic hysteresis modulus when obtained by measuring the deflection of bars under load and by observing the damping of tuning forks. The measurements of damping give values twice as great as the deflection method. It has been found that the damping of a tuning fork is unchanged when the fork is mounted rigidly, suspended by strings, mounted on rubber, or mounted rigidly and unbalanced by adding weights to one prong. Attention will now be given to further experiments employing the deflection method.

Optical heterogeneity of fused quartz.—Various parts of a single piece of clear fused quartz, from which it was planned to make a standard of refractive index for testing refractometers, were rigorously investigated as to uniformity of refractive index throughout the mass of the sample. The variations found were not only small, but the nature of their distribution indicated that an annealing process might entirely remove them.

Properties of flames.—The properties of flames which affect their stability and efficiency are being studied. An investigation will soon be finished of the relative proportion of carbon monoxide and hydrogen in the gases from flames in which combustion is nearly but not quite complete.

Heat of formation of sulphur.—The heat of formation of sulphur dioxide, at 25° C. and atmospheric pressure, from rhombic sulphur and gaseous oxygen was found to be $+296,890 \pm 200$ absolute joules per mole, or dividing by the factor 4,185, this value becomes 70,940 g-cal₁₅.

Heat of formation of nitric acid.—A method and apparatus for determining directly the heat of reaction between nitric acid and hydrogen to form nitrogen and water has been perfected and measurements of this thermochemical constant are under way.

Identification.—Attention has been given to the identification of typewriting, handwriting, bullets, cartridge cases, and firearms. The bureau's purpose is to establish standards which may be regarded as reasonable minimum requirements for equipment and training for carrying on this work. On numerous occasions the bureau has assisted other departments of the Federal Government in problems of identification.

Fading of dyes.—A spectrophotometric method has been perfected for the quantitative measurement of the degree of fading of dyed fabrics. Tentative standard methods for determining the fastness to washing of dyed fabrics have also been developed, and a machine embodying these methods has recently been placed on the market.

Sole leather.—Tests recently completed show that sole leathers first tanned with chromium salts and then retanned with vegetable materials wear from 25 to 75 per cent longer than the ordinary vegetable tanned sole leathers now chiefly used.

Acid in leather.—Leather prepared with one particular tanning material has lasted two years without appreciable deterioration, although it contained 3 per cent sulphuric acid. Leather prepared with another material showed deterioration in samples containing about 1 per cent sulphuric acid. It appears that the resistance of leather to deterioration by sulphuric acid is influenced by the vegetable material with which it is tanned. A study of the effects of relative humidity upon the deterioration of leather by sulphuric acid indicates that deterioration takes place at a greater rate with high than with low humidities.

This project is sponsored jointly by the Tanners' Council of America and the American Leather Chemists Association, and cooperation is effected through an advisory committee representing these organizations.

Influence of temperature and humidity on the physical properties of rubber compounds.—In cooperation with the American Chemical Society an investigation has been completed of the effect of temperature and relative humidity upon the physical properties of rubber as exemplified by the stress-strain relation and the resistance to abrasion. The effect of relative humidity and temperature upon the resistance to abrasion is of interest to the industry, for it concerns the seasonal tire wear as well as the standardization of the laboratory procedure in determining this property.

Sponge rubber.—A survey of the manufacture of sponge rubber has been made, using samples of sheet sponge of different types obtained from several sources. This investigation covers hardness, porosity, strength, permanent set, water absorption, buoyancy, hysteresis under compression, cushioning properties, and heat insulation.

Abrasion tests for rubber.—A new abrasion-test machine has been designed and built, and data on its performance are being obtained.

Rubber floor tile.—A report covering the properties of rubber floor tile has been prepared and discussed at conferences with manufacturers and users. Further work is planned to make available definite information regarding the physical properties desirable in rubber floor tile and the conditions of service for which it is best adapted.

Properties of electrical insulating materials.—This research has been largely confined to the electrical properties of compounds of sulphur with pure rubber hydrocarbon. A series of 17 compounds has been studied in which the sulphur content varied from 0 to 32 per cent in steps of 2 per cent. The dielectric constant, power factor, and resistivity of each member of the above series were measured at approximate temperatures from -77° to $+102^{\circ}$ C., the dielectric constant and power factor being measured at 60, 1,000, and 3,000 cycles. A comparative method for measuring the thermal conductivity of electrical insulating materials has been developed.

Storage-battery investigation.—Experiments to determine the effect of expanders as well as variations in the treatment of plates after pasting have been made. The causes of corrosion of positive plates in large storage batteries, such as those used in submarines, are being studied. An investigation to determine the possibility of using other material than antimony to harden the lead of the grids has been begun.

Wind pressure on structures.—Measurements of the wind pressure on a relatively smooth cylindrical stack 10 feet in diameter and 30

feet high in a natural wind have shown a pressure corresponding to approximately 10 pounds per square foot (projected area) at a speed of 100 miles per hour. On the brick stack of the bureau's power plant values corresponding to 15 to 17 pounds per square foot at 100 miles per hour have been noted. The wind pressure in model tests is known to increase with the height-diameter ratio and with roughness, and the same appears to be true of large structures in natural winds. For general use the bureau can not at present recommend any reduction below the commonly used figure of 20 pounds per square foot at 100 miles per hour.

Spectrochemical analysis.—New descriptions of the arc and spark spectra of lanthanum, chlorine, bromine, iodine, arsenic, krypton, and xenon have been prepared. These have led to the classification of nearly all the lines in the first (arc) spectrum of each and have given information as to the most sensitive lines for spectrochemical detection and quantitative estimation of small quantities, of the elements. In each, excepting arsenic, the main features of the second (spark) spectrum have been found, and the strongest spark lines classified. About 100 samples of metals, alloys, salts, and miscellaneous materials were examined by spectrographic methods. Impurities were identified in proof gold of the Bureau of the Mint and a higher standard of proof is now being maintained by the spectroscopic method of testing.

Atomic structure investigations.—The rate of disappearance of ions and electrons in an ionized gas by recapture of the electrons has long remained an unknown quantity in ionization problems. Attention has been centered on measurements of this probability of recombination. The intensity of the radiation resulting from the capture process is a convenient measure of the rate of recombination. The results give reliable values for the relative probabilities of capture for electrons of different speeds into various atomic levels, while a study of the converse process, ionization of atoms by light, fixes the absolute value of the probabilities.

Photographic emulsions.—An investigation relating the hydrogen and bromide ion concentration with the sensitivity of the emulsion shows that these control sensitivity directly, as well as through their effect on the efficiency of both nuclear and dye sensitizers. Experiments on sensitization by sulphites indicate that this is peculiarly dependent on removal of soluble bromide. The study of the effect of washing and coating pH was therefore extended to include the effect of bromide ion concentration. A study of a particular dye bath has been made to develop correct principles governing the use of two dyes.

Research associates.—The following table gives the names of associations and manufacturers cooperating with the bureau under the research associate plan, together with the number of associates and the problems on which they are engaged:

Research associates at the Bureau of Standards

Assigned by—	Number	Specific project
American Association of Textile Chemists and Colorists, W. E. Hadley, secretary, care of Clark Thread Co., Newark, N. J.	1	Assisting in study of methods for testing fastness to light of dyed fabrics.
American Chemical Society, rubber section, Mills Building, Washington, D. C.	1	Physical testing of rubber.
American Dental Association, Columbus, Ohio	3	Study of dental materials.
American Electric Railway Association, care of R. H. Dagleish, president, Capital Traction Co., Washington, D. C.	1	Testing of oils for use on street railways.
American Electroplaters Society, George Gehling, secretary-treasurer, 5001 Edmund Street, Philadelphia, Pa.	2	Spotting out of plated finishes.
American Face Brick Association, 130 North Wells Street, Chicago, Ill.	1	Prevention of stain on brick structures.
American Foundrymen's Association, Cleveland, Ohio	1	Liquid shrinkages in metals.
American Gas Association, 342 Madison Avenue, New York, N. Y.	3	Methods of testing gas appliances to determine their safety.
American Petroleum Institute, 250 Park Avenue, New York, N. Y.	7	Thermodynamic properties of petroleum products; corrosion in pipe lines.
American Society of Mechanical Engineers, 29 West Thirty-ninth Street, New York, N. Y.	2	Steam tables.
American Society for Testing Materials, 1315 Spruce Street, Philadelphia, Pa.	3	Cement testing.
Asphalt Shingle and Roofing Institute, 285 Madison Avenue, New York, N. Y.	1	Relative values of different fibers used in roofing felt.
Associated Knit Underwear Manufacturers of America (Inc.), 329 Main Street, Utica, N. Y.	1	Standardization and simplification of underwear sizes.
Atlas Lumnite Cement Co., 25 Broadway, New York, N. Y.	3	Properties of high alumina cement.
Brown Co., Berlin, N. H.	2	Permanency of papers.
Bunting Brass & Bronze Co., 715-755 Spencer Street, Toledo, Ohio.	1	Tenacity of bronze.
Bureau of Efficiency, Washington, D. C.	1	Durability of currency paper.
Cast Iron Pipe Research Association, 566 Peoples Gas Building, Chicago, Ill.	2	Study of cause of soil corrosion of cast-iron pipe.
Celite Co., Los Angeles, Calif.	2	Investigation of workability of concrete.
Celotex Co., 645 North Michigan Boulevard, Chicago, Ill.	1	Heat transmission of materials.
Cerro de Pasco Copper Corporation, 44 Wall Street, New York, N. Y.	1	Development of new uses for metallic bismuth.
Committee on Glass, E. C. Sullivan, chairman, Corning Glass Works, Corning, N. Y.	1	Research in physical properties of glass.
Common Brick Manufacturers Association of America, 2121 Guarantee Title Building, Cleveland, Ohio.	1	Sound measurements and compression tests of brick walls.
Copper and Brass Research Association, 25 Broadway, New York, N. Y.	1	Investigation of safe loading of corrugated copper roofing, etc.
Cotton Textile Institute (Inc.), 320 Broadway, New York, N. Y.	3	Study of specific uses for cotton materials.
Dardelet Thread Lock Corporation, 120 Broadway, New York, N. Y.	6	Investigation of Dardelet lock thread.
Department of Scientific and Industrial Research, London, England.	1	Research in Portland cement.
Elevator Safety Code Committee, subcommittee on research, approval, and interpretation, American Standards Association (formerly American Engineering Standards Committee), 29 West Thirty-ninth Street, New York, N. Y.	3	Elevator safety equipment; development of methods and instruments; construction, maintenance, operation, etc.
Engineering Foundation, 29 West Thirty-ninth Street, New York, N. Y.	1	Preparation of bibliography on wire rope.
Hugh L. Cooper Co., 101 Park Avenue, New York, N. Y.	1	Clays in concrete mixtures.
Indiana Limestone Co., Bedford, Ind.	1	Properties of Indiana limestone; water-proofing, discoloring, etc.
International Association of Electrotypers of America, George C. Stock, field secretary, Leader Building, Cleveland, Ohio.	1	Nickel electrotyping.
International Education Board, 61 Broadway, New York, N. Y.	1	Spectroscopic research.
Marine Underwriters Committee, 82 Beaver Street, New York, N. Y.	1	Investigation of spontaneous combustion in jute fibers, etc.
Metalloid Co., 53 West Jackson Boulevard, Chicago, Ill.	1	Study of composition and absorptive properties of metalloid and similar clarifying agents.
Midvale Co., Nicetown, Philadelphia, Pa.	1	High-temperature testing of metals.
National Association of Glue Manufacturers, J. R. Powell, consulting secretary, Armour Glue Works, 1355 West Thirty-first Street, Chicago, Ill.	1	Glue for use in paper sizing.
National Association of Hosiery & Underwear Manufacturers, 334 Fourth Avenue, New York City.	2	Development of methods of measuring hosiery; standardization of twist with respect to dye application.
National Lead Co., 105 York Street, Brooklyn, N. Y.	1	Research in pigments.

Research associates at the Bureau of Standards—Continued

Assigned by—	Number	Specific project
National Research Council, Washington, D. C.	8	Testing materials; structure of the alkali atoms; insulating liquids.
National Terra Cotta Society, 19 West Forty-fourth Street, New York, N. Y.	3	Investigation of architectural terra cotta.
Phillips Petroleum Co., Bartlesville, Okla.		Design of burners for propane gas.
Portland Cement Association, 33 West Grand Avenue, Chicago, Ill.	7	Constitution and hardening of Portland cement.
Society of Automotive Engineers (Inc.), 29 West Thirty-ninth Street, New York, N. Y.	4	Vapor lock; cooperative fuel research.
Steel Castings Development Bureau, 500 Stock Exchange Building, Philadelphia, Pa.	1	Research in steel castings.
Steel & Tubes (Inc.), Cleveland, Ohio.	3	Tension and compression tests of steel tubing.
United States Manufacturers of Cream of Tartar (Inc.), 39 West Thirty-eighth Street, New York, N. Y.	1	Physical and chemical characteristics of baked products.
Welded Steel Tubes (Inc.), 224 East One hundred and thirty-first Street, Cleveland, Ohio.	1	Preparation of reports on tubes.

TESTING RAILROAD-TRACK AND OTHER SCALES (\$49,085)

Railroad-track scales.—A total of 726 tests of railroad-track scales in 23 States was made. Of this number 434 were owned by railroads, 288 by industries, 4 by the Federal Government, and 1 by a municipality. Fifty-four scales were adjusted to improve their weighing accuracy, and faulty mechanical conditions in 12 scales were corrected by bureau inspectors.

Track-scale test results.—Of the scales tested 71.8 per cent were correct within the prescribed tolerance. The average error for all scales tested was 0.20 per cent of the applied test loads. Both of the figures establish new records for accuracy. Corresponding figures for the preceding year were 70 and 0.23 per cent, respectively.

The comparative standing of the eastern, southern, and western districts with regard to the proportion of correct scales is represented by the respective values 68.2, 65.4, and 75 per cent.

Master-track scale tests.—Fifteen of the 19 master-track scales in use throughout the United States were tested. With the exception of two scales which had undergone overhauling or modification since the last preceding test, all proved to be accurate within the "maintenance tolerance" which allows maximum weighing errors of approximately 0.02 per cent of the test load values.

Track scales for weighing grain.—Ninety-seven of the scales tested this year were in grain weighing service and therefore subject to a special tolerance fixed by the Interstate Commerce Commission. Forty-three scales or 44.3 per cent were within the tolerance. The average weighing error for all scales was 0.15 per cent. Repeated tests of grain weighing track scales show that the majority of this equipment is not adapted for service under the special tolerance requirement and that frequent repair and adjustment of the equipment to not compensate for deficiencies of design or construction.

Test car calibrations in the field.—Twenty-seven track-scale test cars were weighed by substituting them against the standard weights of the field units. This service is extended at remote points where transportation of a test car to a master scale would be impractical or where the test car wheel base exceeds the rail length of the con-

ventional master scale. Recently, several, cars of long wheel base type have been modified to allow ready conversion to a short wheel base.

Bureau master scale and test car depot.—New load-bearing blocks of improved design were made and installed in the longitudinal extension levers of the master scale at Clearing. With the exception of more or less slight functional variations, the performance of the scale has since been satisfactory.

Forty-four track-scale test cars received at the depot this year were weighed and adjusted to standard weight value. A seal designating formal certification of the car as a test weight was affixed to each car designed and built according to approved standards.

Research and investigation.—A cooperative activity with the National Scale Men's Association resulted in a set of specifications formally approved by that association for the repair of heavy capacity scales.

Cooperation with States in weights and measures matters.—Formal conferences of State and local weights and measures officials have been attended in Indiana, Maine, Massachusetts, Michigan, Minnesota, New Jersey, New York, Ohio, Pennsylvania, Texas, and Virginia. Incident to these meetings, conferences have been held with officials in Alabama, Delaware, Georgia, and Tennessee.

Cooperation with other Government departments.—Numerous consultations have been held with representatives of other Federal departments and of the District of Columbia on questions of weighing scales, measures, etc., and a considerable amount of equipment has been examined or tested for the agencies mentioned.

STANDARDIZATION OF EQUIPMENT (\$192,123)

General conferences on simplified practice.—Sixteen general conferences were held to adopt simplified practice recommendations. The first general conference in connection with a new service of the division of simplified practice resulted in the adoption of a regional recommendation. Simplified practice recommendations have been accepted covering 98 commodities and 14 simplified practice recommendations and 1 regional recommendation are now in process of acceptance. Printed recommendations have been issued for 88 commodities.

Number of acceptances to simplified practice recommendations.—A total of 1,199 acceptances have been received from trade associations and other organized groups, as well as individual acceptances from 20,790 manufacturers, distributors, and users.

Revision and reaffirmation conferences.—Forty-one conferences were held by the members of the industries concerned, resulting in the revision of items in 10 of the simplified practice recommendations already in effect and the reaffirmation of 31 recommendations, or 75.5 per cent. This shows an increasing stability in simplified practice recommendations over last year when only 25, or 67.5 per cent of the 37 recommendations reviewed, were reaffirmed without change.

Adherence to simplified practice recommendations.—Field surveys showed that the average degree of adherence for 26 commodities was 85.43 per cent. This compares favorably with the figure for the previous year which was 86.86 per cent and covered 30 commodities.

Degree of adherence obtained by actual survey

S. P. R. No.	Commodity	Degree of adherence	S. P. R. No.	Commodity	Degree of adherence
		<i>Per cent</i>			<i>Per cent</i>
1	Vitrified paving brick.....	70.10	48	Shovels, spades, and scoops.....	96.62
4	Asphalt.....	91.00	50	Bank checks and other commercial instruments.....	82.64
6	Files and rasps.....	93.14	51	Die-head chasers.....	100.00
7	Face and common brick.....	89.00	52	Staple vitreous china plumbing fixtures.....	88.77
17	Forged tools.....	93.00	54	Sterling silver flatware.....	94.89
20	Steel barrels and drums.....	90.83	60	Packing of carriage, machine, and lag bolts.....	67.14
22	Paper.....	64.78	61	White glazed tile and unglazed ceramic mosaic.....	86.63
26	Steel reinforcing bars.....	96.21	62	Metallic cartridges.....	99.00
28	Sheet steel.....	94.28	75	Composition blackboard.....	86.54
29	Eaves trough and conductor pipe.....	93.55	79	Malleable foundry refractories.....	64.31
30	Roofing ternes.....	100.00		Average.....	85.43
31	Loaded paper shot shells.....	80.45			
36	Milling cutters.....	54.40			
41	Insecticides and fungicides.....	82.00			
43	Paint and varnish brushes.....	85.64			
46	Tissue paper.....	76.60			

Field surveys in progress.—Surveys of existing varieties are in progress for 20 industries.

Benefits of simplified practice.—Correspondence from the acceptors of simplified practice recommendations continues to bring in interesting examples of savings that are being effected. The ultimate realization of the potential benefits of simplified practice by the consumers of the country will, of course, take some time, but indications, of which the following is a sample, clearly illustrate that none of the claims made for it are beyond the realm of probability:

On the item of shovels alone we are pleased to advise that, due to the elimination of a vast number of sizes and styles, our inventory on this line has been cut practically in two, without any complaints whatever from the consuming trade. This proved of such benefit to us that after the inventory was straightened out and the old sizes disposed of we were able, in January of this year (1929), to reduce our prices to the consuming trade ranging from \$1 to \$2.50 per dozen.

Regional recommendations.—The division of simplified practice has been developing a new service to industry, in the form of regional recommendations. Hitherto the work has been confined to projects which, from their inception, were national in scope. It has, however, become increasingly evident that there is a large field for service in programs covering only a part of the United States. Obviously, some limit must be set up beyond which the bureau can not be expected to go, and for the present it has been decided to limit this new activity to (a) natural products or commodities, the nature of which varies in different parts of the country, and (b) to programs which hold forth a definite promise of ultimately developing into national recommendations.

During the last quarter a general conference was held for the development of one such regional recommendation, covering screen sizes and terminology of high-volatile bituminous coal in the Great Lakes region.

Commercial standards.—This classification covers standards of grade, quality, measurement, tolerances, and other specification requirements established voluntarily by industry as a basis for marketing and certifying various commodities. In cooperation with the Bureau of Foreign and Domestic Commerce standards are translated into foreign languages as a basis for promoting foreign trade.

Fifteen general conferences were held, covering the following commodities: Surgical gauze, steel pipe nipples, wrought-iron pipe nipples, standard weight malleable iron or steel screwed unions, plain and thread plug and ring limit gage blanks, builders' template hardware, brass pipe nipples, regain of mercerized cotton yarns, domestic and industrial fuel oils, dress patterns, boys' blouses, waists, shirts, and junior shirts, men's pajamas, wall paper, diamond core-drill fittings, and hickory golf shafts.

A satisfactory majority of acceptances have been received and the success of the following projects has been announced: Stoddard solvent, staple porcelain (all clay) plumbing fixtures, steel pipe nipples, wrought-iron pipe nipples, brass pipe nipples, regain of mercerized cotton yarns, and dress patterns.

The following four commercial standards have been issued in printed form: Clinical thermometers (CS1-28), Stoddard solvent (CS3-28), staple porcelain (all-clay) plumbing fixtures (CS4-29), steel pipe nipples (CS5-29).

Radiator investigation.—To develop a logical basis and test for the rating of radiators used for heating purposes, a test room of average size was built, having one wall exposed to a refrigerated space, corresponding to the exterior wall of a building. In testing a radiator measurements are made of the useful heat output as well as the total heat output. The latter determines the capacity of the radiator, and the former is a measure of its effectiveness as a heater. The two factors are essentially independent, but it is hoped that they can be combined in such a way as to form a logical basis for ratings.

Standardization of fire-control instruments for the Army.—The Ordnance Department of the Army has adopted the plan of standardizing optical systems to govern the design of future fire-control instruments, which was proposed some years ago by a member of the bureau's staff. This will apply to all optical instruments controlled by the Ordnance Department and will result in greatly simplifying the problems of design, production, and maintenance.

Dry-cell standardization.—Qualification tests on dry cells collected at intervals of approximately six months have been in progress continuously.

Specifications for storage batteries.—Attention has been given to tests of storage batteries to obtain information necessary in preparing specifications for automotive and other types of batteries. While good progress has been made on the specifications for battery performance, the tests to determine quality of the cases are proving a serious obstacle.

Safety codes.—A report on dry cleaning was prepared for the National Safety Council. Sponsorship for the safety code for aeronautics was discontinued. In connection with the elevator safety code a handbook for elevator inspectors has been prepared. Members of the staff have participated actively in the work of the safety code correlating committee and in sectional committees preparing and revising safety codes for various industries. Codes for refrigeration, window washing, woodworking, factory lighting, street traffic signs, signals, and markings, and for floor openings, railings, and toeboards, were completed. Work was continued on codes for walkway surfaces, conveyors and conveying machinery, and colors of gas-mask canisters.

Directories of laboratories.—In a second revised edition of the Directory of Commercial Testing and College Research Laboratories data are given concerning the laboratories in 196 colleges, and 294 commercial testing laboratories, with 94 branch laboratories or offices. A directory of all Federal governmental testing laboratories has been prepared for the use of the Federal Government purchasing agents.

Specifications in various industries.—The second volume of the bureau's encyclopedia series, entitled "Standards and Specifications for Nonmetallic Minerals and Their Manufactures," has been prepared for printing.

Cooperation with public purchasers.—In connection with the compilation of material for the National Directory of Commodity Specifications and the Standards Yearbook, and the inauguration of the so-called certification plan, the bureau has cooperated with the public purchasing officers in all of the 48 States and with all of the State highway commissions. It has established contact with more than 15,000 additional public purchasers for all of the cities throughout the country, all of the municipalities having the city-manager form of government, and many counties, public schools, hospitals, and other public institutions.

Facilitating the use of specifications.—The certification plan has been so extended as to include commodities covered by a total of 248 United States Government master specifications. More than 7,500 separate requests for listing as willing to certify to compliance with the specification requirements have been received from about 2,000 manufacturers. Self-identifying quality-guaranteeing labels are now being used by manufacturers of certain staple lines of merchandise to show that they comply with the requirements and tests of certain of the specifications.

STANDARD MATERIALS (\$10,824)

Distribution of standard samples.—A direct result of the use of the standard samples of ores, metallurgical products, and pure chemicals prepared and distributed by the bureau is a saving of thousands of dollars a year through improved manufacturing operations and the avoidance of costly disputes based on faulty analysis. The standard sample fund is unique in that the return to the United States Treasury in fees and accumulated stocks of salable samples has always exceeded the appropriation. In 1928 and 1929 \$16,062 was received from the sale of 7,336 samples and approximately \$45,000 worth of standard samples were added to the salable samples on hand.

INVESTIGATION OF RADIOACTIVE SUBSTANCES AND X RAYS (\$31,741)

Measurement of X-ray dosage.—A precise measurement of the intensity (power) of X rays is one of the most difficult problems associated with the study and application of this radiation. In therapeutic applications measurement of the dose administered is of prime importance, yet it was not until the 1928 international conference on X rays at Stockholm that a unit for expressing X-ray dosage and its method of measurement was agreed upon. Inasmuch as leading laboratories were then at variance in their measurements

of the same radiation by as much as 4 per cent of the magnitude involved, the bureau has been engaged in identifying the possible sources of the existing discrepancy, and has met with considerable success. The theory of the measurement remains unquestioned, but sufficient precautions do not appear to have been taken to insure that experimental conditions fulfilled the requirements of the theory.

X-ray and radium protection.—The (1928) International Congress on Radiology adopted proposals on X-ray and radium protection which various national committees have been formed to promulgate. A member of the bureau's staff was appointed chairman of our national committee.

Tests of radioactive preparations.—Upon these tests the prices of the preparations are based. During the year 1,050 preparations, ranging in radium content from 0.05 to 100 mg. and totalling 11,300 mg., were tested.

UTILIZATION OF WASTE PRODUCTS FROM THE LAND (\$53,148)

Wall board from cornstalks.—The bureau continued to operate the plant at Ames, Iowa, in cooperation with the Iowa State College, for the manufacture of insulating board from cornstalks. With new types of equipment recently installed wall board has been made with a thickness of $\frac{1}{2}$ inch and twice as strong as any insulating board on the market. An insulating board designed for refrigerators, 2 inches thick without lamination, can also be made.

Small-scale experiments have been completed on the manufacture of pressed board from cornstalks, which is intended to be used as a substitute for lumber.

A process has been developed for the manufacture of a new material called maizolith, which is also made from cornstalks and has many characteristics of hard rubber or vulcanized fiber.

Manufacture of xylose.—Laboratory work on the manufacture of xylose from cottonseed hulls has been completed. The bureau has erected and is operating a semicommercial factory at the plant of the Federal Phosphorous Co., Anniston, Ala., in cooperation with the University of Alabama and the Alabama Polytechnic Institute. The factory is designed to make 100 pounds of xylose per day.

This factory started operation on March 16. It is planned to use other raw materials, such as peanut shells and corncobs, and to reduce cost and improve efficiency.

Samples of xylose are being supplied to interested individuals and concerns who are assisting in finding a market for the material. There is a possibility of it being used in the dyeing and tanning industries, for use in foodstuffs, for manufacture of chemicals, explosives, furfural, and for manufacture of alcohol to be used as solvent for lacquer, etc.

Utilization of cornstalks.—A field survey of the economic possibility of using cornstalks as an industrial raw material has been completed by an economist retained for the purpose. This included a study of the cost of collecting cornstalks, of the cost of manufacture of insulating board and wall board from competitive materials, and of the probable expansion of the markets of these products.

Miscellaneous.—Many preliminary investigations of other types of waste land products have been conducted. A study of the Texas

sunflower indicated small possibility of the industrial use of this plant at present.

Cotton burs were found to be high in potash and therefore valuable as a fertilizer.

Experiments with artichoke tops show that they can be used for the production of a strong brown paper.

Peanut shells contain a considerable quantity of xylose, and it is possible that the fiber left after the extraction of the xylose may have some value.

Complete chemical and microscopical analysis of wheat straw have been completed, the stem and the nodes being analyzed separately. Based on this information we have now started to investigate the paper-making qualities of straw.

The acid which is produced by the oxidation of xylose has certain characteristics which may make it of value in the tanning and dyeing industries. The bureau has produced this acid in the laboratory and is now investigating the optimum conditions for its manufacture.

INVESTIGATION OF AUTOMOTIVE ENGINES (\$26,833)

Automobile engine acceleration.—The effect of fuel characteristics and operating conditions on engine acceleration has been studied. To evaluate the influence of engine design, specified acceleration tests will be repeated by request on representative engines at the laboratories of certain automobile companies. These field tests will conclude one phase of the joint motor-fuel research started seven years ago in cooperation with the American Petroleum Institute, the National Automobile Chamber of Commerce, and the Society of Automotive Engineers.

Phenomena of combustion.—Using the soap bubble as a constant pressure bomb, an intensive study in cooperation with the National Advisory Committee for Aeronautics has been made of the explosive reaction with oxygen of butane and of composite fuels containing butane as one constituent. The results show that the relations already found to hold for simple gases and their mixtures hold also for complex hydrocarbon molecules. The equivalent reaction order of a composite fuel may be determined from the reaction orders of its components, and the velocity constant of the fuel may also be determined from the velocity constants of those components.

Antiknock characteristics of fuels.—The bureau is cooperating with representatives of the automotive and petroleum industries in an organized attempt to reach agreement upon satisfactory methods of measuring and expressing the tendency of motor fuels to knock or detonate. Specially designed detonation test engines have been distributed to the laboratories represented on the committee and each laboratory will make the same series of preliminary tests with this engine on six special fuels. The ultimate object is the general adoption of a common test engine and procedure as a tentative standard.

Gasoline volatility.—The final form of the correlation between the distillation curves of the American Society for Testing Materials and the complete equilibrium air-distillation data for 38 fuels, gains accuracy by taking into account the slope of the distillation curve, and appears to furnish a comprehensive answer to the problem of equilibrium volatility of hydrocarbon fuels of any degree of complexity in the temperature range covered by gasolines. This basic investiga-

tion should be supplemented by a study of the differences between volatility under equilibrium conditions and under nonequilibrium conditions such as exist in automotive engine manifolds.

Vapor lock in airplane fuel systems.—The investigation of vapor lock began with a study of the contribution of the various constituents of a gasoline to the total vapor pressure, when every opportunity was given for bubbles to form. Bubble formation and growth under typical flow conditions are at present being studied.

Engine tests of lubricating oils.—A six-cylinder bus engine has recently been set up for testing automobile engine oils under constant conditions, a reference oil being used to serve as a check on changes taking place in the engine itself. Tests thus far have been confined to the reference oil.

Vibration of motor vehicles.—Vertical accelerometers are used by the Bureau of Standards in estimating the comparative riding qualities of motor vehicles. They are also used by the Bureau of Public Roads in estimating the vertical impact forces which tend to wear out the road surface. A machine for calibrating such instruments has been set up at the Bureau of Standards, and the two bureaus are cooperating in the calibration of various types of vertical accelerometers.

Automotive headlighting.—The bureau has continued to cooperate with the Society of Automotive Engineers in the investigation of headlighting from the automobile driver's point of view. The light spread required for safe driving at various speeds over typical roads was determined photographically. A multiple-element photometer has been developed for estimating the approximate light intensity thrown in the driver's eyes when meeting another car on the road.

Cooperative investigations in the automotive field.—The appropriation for the automotive work is not sufficient to carry on investigations of fundamental importance in this field. However, it has been used as a nucleus for cooperative research in which other branches of the Government and industrial associations have joined. Some valuable research has thus been made possible.

INVESTIGATION OF DENTAL MATERIALS (\$5,421)

Physical and chemical properties of dental materials.—The investigation of the physical and chemical properties of inlay materials, amalgams, plasters, and waxes has continued, and purchase specifications have been drawn up for these materials. Assistance has been given to dental colleges, manufactures, and dental testing laboratories in the design, selection, and installation of testing equipment for dental materials.

Cooperative dental research.—The dental research in cooperation with the American Dental Association, which was begun last year, has been continued and most satisfactory relations have been maintained. The \$7,500 per year appropriated by the association for this work has made possible the establishment of one full-time research associateship and the part-time employment of two additional men. The progress made has been most gratifying to the bureau and, it is believed, satisfactory to the association. Defective dental materials and technics have been pointed out to the profession and to manufacturers, and improvement in the quality of certain materials is already apparent.

POWER-PLANT EQUIPMENT (\$100,000)

Equipment.—The boiler-room installation has been completed with the exception of two boilers which are to be moved from another location and for which a contract has been placed. Steam connections to the old plants have been completed and the new boiler plant will be in full operation beginning July, 1929.

Cooling pond.—Although the power-plant building proper was completed last year, one unit of the water-spray pond was completed this year. This pond will serve as a source of supply for condenser circulating water and will, when put in service, greatly conserve our water supply.

TRANSFERRED FUNDS (\$339,923)

Organization and projects.—During the year funds were transferred from the following branches of the Government covering the projects listed:

Aeronautics Branch, Department of Commerce:

- Lighting of airways.
- Radiobeacons.
- Testing of commercial airplane engines.

Bureau of Engraving and Printing:

- Electrodeposition problems.
- Paper currency.
- Postage stamps.

Bureau of Foreign and Domestic Commerce: Preparation of directories of specifications.**Coast and Geodetic Survey:**

- Development of seismometers.
- Making of special castings.

National Advisory Committee for Aeronautics:

- Aerodynamics.
- Fatigue of duralumin.
- Light alloys for aircraft.
- Power plants.
- Steel and duralumin tubing.
- Substitutes for parachute silk.

Navy Department:

- Aircraft instruments.
- Airship girders.
- Altitude control of carburetors.
- Corrosion of metals.
- Gas-cell fabrics for airships.
- Gaseous fuels for aircraft.
- General aeronautical fabrics.
- Ignition systems for aircraft engines.
- Production of optical glass.
- Storage batteries for submarines.

War Department:

- Application of supercharger to Curtiss airplane engine.
- Bomb ballistics.
- Development of machine guns.
- Embrittlement of duralumin.
- Experimental length gages.
- Problems of friction and lubrication.
- Radio transmission.

Many of these projects were supported partly by bureau and partly by transferred funds. The more important of these have already been described under the appropriate bureau fund. Important investigations supported wholly by transferred funds include the following:

Type testing of commercial airplane engines.—The importance of testing new designs of commercial engines before permitting their use in licensed aircraft is shown by the fact that of 24 engines received for test 12 failed, 5 were withdrawn, and 7 were approved. The failures were due in many cases to faults which would have been evident to the manufacturer had he done more adequate preliminary testing. Three engines which failed initially were corrected and have passed a second test. Engine-testing equipment, including three complete torque stand units, has been installed at Arlington Farms. This plant takes the place of a single test stand at College Park and will permit testing on the average of one engine a week.

Effect of spark character on ignition ability.—A single-cylinder testing engine is being used under controlled operating conditions to ascertain whether one type of spark is superior to another in its ability to ignite the mixtures which actually occur in engines. Methods have been devised for estimating the "dryness" of the explosive charge at the end of the compression stroke and for comparing the "sphere of influence" of different sparks. The efficiency of aircraft ignition systems shielded to prevent interference with radio communication is also being studied. This work was supported jointly by the National Advisory Committee for Aeronautics and the Bureau of Aeronautics of the Navy Department.

Prevention of embrittlement of duralumin corrosion and of deterioration of magnesium alloys by corrosion.—Two more technical notes on the progress of the work, which is supported by the Navy Department, War Department, and National Advisory Committee for Aeronautics, have been published by the last-named organization. Two other progress reports were published.

Exposure tests at the bureau, Hampton Roads, Va., and Coco Solo, Canal Zone, on bare and coated duralumin and magnesium or magnesium alloy specimens are in progress. A total of 2,373 exposure or control specimens remain to be tested. So far no thoroughly satisfactory protective coating has been found other than pure aluminum, which has so far been applied only to duralumin. All exposure and laboratory tests continue to show that duralumin quenched in cold water and naturally aged is greatly superior to that quenched in hot water or oil, and to that aged at elevated temperatures. The Alclad duralumin is extremely resistant to the type of corrosion that causes embrittlement. Even under repeated flexure and corrosion combined, the most severe set of conditions that can be met, the Alclad duralumin was vastly superior. Under severe corrosion and in repeated flexure at 10,000 pounds per square inch hot-water quenched duralumin broke in 5 days, cold-water quenched lasted 30 days, but became brittle in 7 days, while Alclad duralumin was unharmed after 24 days and ran 65 days without breaking. The life of the Alclad duralumin when tested at three times the stress, 31,000 pounds per square inch, was about the same as the cold-water quenched bare duralumin at 10,000 pounds per square inch. Alclad duralumin is an outgrowth, in commercial hands, of fundamental data obtained by the bureau in this cooperative work, on the good protection afforded by an aluminum coating, and is now in wide commercial use in aircraft.

Nickel deposition.—A study of the colorimetric and electrometric methods of measuring the pH or acidity of nickel-plating solutions was conducted, and the corrections to be applied to colorimetric readings were determined.

Iron deposition.—Experiments on the electrolytic production of iron printing plates have been continued. One unit for carrying out this process is just being installed at the Bureau of Engraving and Printing.

Gas-cell fabrics.—Practical tests of gas cells constructed with the new gas-cell fabric developed at the bureau have shown that the rubber film in the fabric needs improvement. Considerable time has been spent in the factory where the large-scale production of this fabric has been undertaken, in order that the experience gained at the bureau might be translated into industrial practice. Some preliminary tests indicate that a new type of gas-impermeable material, quite different from the fabric referred to above, offers considerable promise. It will be further investigated.

Aircraft in commerce—Radio.—In cooperation with the Aeronautics Branch of the Department of Commerce a new visual type of beacon transmitter was developed, marking out any number of courses, up to 12, at any desired angles. Changes were made in the visual receiving indicator to improve its operating characteristics and to adapt it to the use of the new beacon. A method for aiding landing in fog was designed and the equipment constructed. Methods of shielding airplane engine ignition systems were studied; in cooperation with the aircraft and radio industries a shielding assembly was developed which is satisfactory from an airplane operating standpoint and also effective from a radio standpoint. Manufacturers of radio receiving sets for use on airplanes submitted preliminary designs of their sets and suggestions were made as to improvements in design. The development of a direction finder for use aboard aircraft, with visual indication, was begun. A complete installation of shielding and radio receiving equipment was made on an airplane of Pitcairn Aviation (Inc.).

Lighting of airways.—A series of field observations on an experimental beacon consisting of a neon lamp, an incandescent lamp with red color filter matching the neon color, and a clear incandescent lamp, was made during foggy weather. It was found that neon light has no superiority over light of the same color and intensity from incandescent lamps as regards visibility through fog, haze, rain, or clear air.

A series of tests on different methods of illuminating wind-indicator cones is in progress, and an improved reflector system for lighting the indicators has been developed.

Vertical component seismometer.—A design has been completed and construction started on a vertical component seismometer for the Coast and Geodetic Survey. This seismometer is to be equipped for electromagnetic and optical magnification and electromagnetic damping and will form a companion instrument to two horizontal component seismometers of the type previously developed in this bureau.

Wind-tunnel turbulence.—Measurements of the turbulence in the bureau's three wind tunnels have been completed. It has been found that the effects of turbulence afford a fairly complete explana-

tion of the discrepancies in the results obtained in different wind tunnels with the airship models circulated by the National Physical Laboratory.

High-speed airfoil tests.—Results of measurements of the aerodynamic characteristics of 24 airfoils at speeds up to and slightly above the speed of sound have been published by the National Advisory Committee for Aeronautics.

Aileron investigation.—Results of work for the Aeronautics Branch of the Department of Commerce on the effect of variation of chord and span of ailerons on rolling and yawing moments in level flight has been published by the National Advisory Committee for Aeronautics.

Strength of aircraft tubing.—The strength of tubing has been found to depend greatly upon the yield point of the material. As the yield point of the tubing used in this investigation was considerably higher than the specified minimum, it seems possible to raise the yield point requirements and thus use higher stresses with safety.

Airship girders.—Further developments have been made leading to more economical inspection testing of these girders. Comparative tests at the bureau and the Goodyear Zeppelin Corporation have been carried out in connection with the new 6,500,000 cubic-foot airship now building for the Navy.

Aircraft instrument investigation.—Investigations to provide a basis for the specification of performance of aircraft instruments have been carried out for the Bureau of Aeronautics on bank indicators, altimeters, tachometers, air-speed indicators, oxygen equipment, and bakelite cases.

GENERAL RECOMMENDATIONS

There was set forth in last year's report a detailed statement of some of the more urgent needs of the Bureau of Standards for its future development, and this program has been indorsed by the visiting committee. It includes more adequate support for fundamental research relating to standards and the determination of fundamental constants of importance to science and industry, including further development of cooperative research with industry; the further extension of the commercial standards group in its program of cooperation with business; and a building program.

The building program includes a hydraulic laboratory, the authorization for which passed the Senate but was not reported out of committee in the House at the last session of Congress; the remodeling of the North Building, which has heretofore been a combination of power plant and shop building into a structure to house all the bureau's shops; the construction of a greatly needed central administration building to relieve much-needed space for laboratories in other buildings and provide suitable quarters for the commercial standards group which was recently transferred from down town, resulting in very serious congestion, and also providing for adequate space for library, auditorium, and the central administrative functions; and a building for high-voltage standardization, testing, and research, of special design to enable the bureau to carry out such operations at 1,000,000 volts. To meet the needs of the Federal Radio Commission and keep pace with requirements in the increase of accuracy of radio transmission, provision should be made for sending and receiving stations in the suburbs of Washington. There also will be required eventually

a building to house the fire-resistance work of the bureau; a new mechanical laboratory suitably designed to house heavy equipment for tests and investigation of large structures; enlargement of the dynamometer laboratory for research relating to automotive and aircraft engines; enlargement of the laboratory for low-temperature research; and provision should eventually be made for a building to take care of expanding work, particularly relating to precision measurements in the weights and measures field.

As pointed out in previous reports, increased facilities and personnel are needed at the branch laboratories of the bureau in order to handle in a more satisfactory manner work relating to testing for the various Government departments, and in particular provision should be made for testing on a more comprehensive scale Government purchases of cement and other commodities.

Provision has not yet been made for establishing at the bureau a first-aid station, not only for accidents but for supervision of workers in such fields as radium, X rays, and furnace and chemical operations. I feel strongly that provision for such a station will greatly help the morale and health conditions of the employees working in these fields.

Very truly yours,

GEORGE K. BURGESS,
Director, Bureau of Standards.

BUREAU OF FISHERIES

DEPARTMENT OF COMMERCE,
BUREAU OF FISHERIES,
Washington, July 1, 1929.

The honorable the SECRETARY OF COMMERCE.

DEAR MR. SECRETARY: I have the honor to submit the following summary of the work of the Bureau of Fisheries during the fiscal year ended June 30, 1929.

Fisheries, like agriculture, are divided into a large number of small operating units, largely lacking in capital to conduct fundamental technical research, which has been the basis for the huge profitable expansion in the industrial field. These conditions have retarded the development of the fisheries at home and abroad and made them a subject for national concern and aid. It is especially noteworthy that in this country our fisheries industries are now rapidly developing improvements in handling, manufacturing, and merchandising. It is believed that the bureau is entitled to an appreciable share of the credit for this condition because of the technical assistance it has given in solving the problems of the fisheries and through the training of skilled technologists, who have graduated into the fisheries industries for solving the problems of their employers.

These developments have improved the quality of the products offered the consumers and greatly increased the demand for aquatic products. The intensity of fishing effort has been increased to fill this growing demand and threatens the future supply in places. As a result there is growing concern for the future of our fisheries, resulting in greatly increasing the demands upon the bureau for accurate knowledge regarding the condition of each important fishery and the restrictions that may be necessary to insure a continuance of large-scale operations.

Fishery administration is involved. Many important species are of wide range and migratory habit. The fisheries are prosecuted in State, interstate, and international boundary waters and on the high seas. While each State makes its own laws governing the fisheries within its boundaries, the State authorities and those engaged in the fisheries generally look to the Bureau of Fisheries to make the investigations necessary to determine the condition and trend of each important fishery and to recommend the restrictions needful for maintenance of supply.

Because of land deficiencies of elements important to the health of man and his domestic animals and the losses of fertility through erosion and other factors, and because the seas through the ages have been absorbing these losses, it is desirable that man draw as fully as practicable on the resources of the seas of the earth. This policy not only involves the wise use of existing resources but the development of the science of aquiculture or water farming.

At the present time statistics collected by the bureau reveal that our annual harvest of fishery products approximates 3,000,000,000 pounds, for which our 127,000 fishermen receive \$113,000,000. The pack of canned fishery products in 1928 exceeded 617,000,000 pounds, valued at nearly \$96,000,000. Fishery by-products to the value of \$14,880,000 were produced. The quantities of fish frozen exceeded 113,600,000 pounds—the largest on record. Over 65,000,000 pounds of packaged fresh and frozen fish, or three and one-half times the production of 1926, valued at nearly \$10,000,000, were marketed. In 1928 our imports of fishery products were valued at nearly \$59,000,000 and our exports at \$21,000,000.

The output of fish and eggs from the bureau's stations during the fiscal year amounted to 7,060,000,000, slightly exceeding the record output of 1928. There is continued growth in the number of fish nurseries cooperating with the bureau, from 55 in 1927 to 86 in 1928 and to 114 in the current year, with the result that many waters are now being adequately stocked with fish.

The wisdom of the White law of 1924, broadening the powers of the Secretary of Commerce over the fisheries of Alaska, is evidenced by the improvements in the runs of salmon, the commercial catch of which in 1928 exceeded 517,000,000 pounds, and by the stabilization of the industry.

Under the bureau's program of husbandry the fur-seal herd has been built up to more than 900,000 animals, or more than five times the combined total of all other fur-seal herds in the world. With this growth it has been possible to increase the take of skins from surplus bulls to more than 30,000 per annum. The herd is increasing at the rate of over 5 per cent annually.

The importance of the bureau's international relations on fishery matters is increasing, and rapid strides are being made in the solution of these problems under the most amicable circumstances.

Tribute should be paid to the efficiency of the bureau's personnel, without which the achievements recorded in these pages would not have been possible.

INTERNATIONAL RELATIONS

NORTHERN PACIFIC HALIBUT CONVENTION

The International Fisheries Commission has continued to follow the condition of the halibut fishery through the collection of biological statistics, as is required of it by the terms of the present treaty. These statistics show a continued decline in abundance despite the closed season now in force. However, the work of the commission has been hampered by lack of power to collect complete statistics. This power it requested in its first report.

Vessel operations for the study of the early biological stages were carried on from October 26 to December 10, for the study of the eggs and larvæ from January 10 to April 12, and for the extension of the study of commercial sizes on banks farther west from April 12 to May 18. Halibut were tagged and material was collected for the study of growth, spawning, and migrations off the Shumagin Islands. For the remainder of the time the scientific staff was en-

gaged upon the preparation for publication of scientific reports embodying the results of the statistical work, the tagging operations, and various other phases of the life-history investigations. Several of these reports are ready and should be issued during the coming year.

The continued observation of the fishery has emphasized the necessity for action upon the recommendations of the commission as submitted in its first report. New and more adequate regulations must be adopted to halt the continued decline; and more reasonable powers for the collection of statistical information must be granted the commission if the observation of the fishery is to be continued as carefully as the terms of the present treaty require.

TREATY REGARDING SOCKEYE-SALMON FISHERIES

On March 27, 1929, at Washington, the Secretary of State and the Canadian Minister signed a treaty for the preservation and extension of the sockeye-salmon fisheries of the Fraser River System, which includes the waters contiguous to the State of Washington and the Province of British Columbia.

The treaty includes provision for the establishment of an international fisheries commission of six members, one of the three United States commissioners to be the Commissioner of Fisheries of the United States. The commission is charged with the duty of making a thorough investigation into the natural history of the sockeye salmon and is given the power to maintain hatcheries and develop the fisheries. The commission is also given the power to establish a closed season, when fishing for sockeye salmon will be prohibited, between the 1st day of June and the 20th day of August in each year, and to regulate the character and size of fishing gear that may be used during the open fishing season. The convention is concluded for a period of 16 years, after which it is subject to termination on notice of one year given by the Government of either the United States or Canada.

Formerly the most productive sockeye-salmon fishery engaged in by Americans and Canadians, in recent years the pack has shrunk to such a low figure as to be a cause for real alarm. It is the hope of those interested in the restoration of this fishery to its former greatness that the treaty will be ratified and adequate measures taken to provide for an escapement of fish sufficient to seed the beds properly.

INTERNATIONAL PACIFIC SALMON FEDERATION

This federation was established in the spring of 1925 as an informal organization of the leading fishery executives of the United States, Canada, the Pacific States, British Columbia, and Alaska for the purpose of conducting and systematizing the work of salmon research according to a comprehensive unified program. A meeting was held at Vancouver, British Columbia, April 5, 1929, at which the entire field of salmon research was discussed. With all of the Pacific coast biologists engaged in salmon studies working under a unified program with definite objectives, results are being achieved much more rapidly than would be possible otherwise.

GREAT LAKES FISHERIES SITUATION

On December 5, 1928, the third meeting of the International Fisheries Conservation Council of the Great Lakes was held at Lansing, Mich. With some slight modifications, recommendations made at previous meetings relative to legal sizes of fish and size of mesh of gill nets were reaffirmed. Resolutions were adopted urging (1) the saving of the original statistical records now being collected to insure their accessibility for further study; (2) the adoption of the principle that in all fisheries legislation each species of fish be afforded such protection as will make certain that only fish that have spawned at least once shall be included in the commercial catch; and (3) that in the adoption of closed seasons these shall be seasons closed to commercial fishing, and that the several States, the Province of Ontario, and the United States Bureau of Fisheries shall undertake the collection of spawn for the hatcheries, limiting fishing strictly to the needs of the Federal, Provincial, and State hatcheries.

During the past two years the bureau has taken an active part in (1) the unification and coordination of the scientific work on Lake Erie; (2) the inauguration of a new system of fishery statistics suitable to the need of the biologist; (3) the codification and revision of the commercial fishing laws of Michigan, Indiana, and Ohio, and in cooperating more closely with State authorities and fishermen's organizations to secure specific and uniform laws for each lake; and (4) the inauguration of a series of studies (*a*) on the effect of gear on the fish population, (*b*) fish populations instead of individual species, (*c*) fluctuations in the fisheries, and (*d*) life histories of nine important market species.

To the credit of several of the States, Michigan in particular, it should be said that the fisheries have been the subject of much closer study and important legislative action than for many years before. Until all of the governments bordering each of the lakes work in closer harmony in enacting needful legislation, the seriousness of the situation can not be considered as having been relieved.

NORTH AMERICAN COMMITTEE ON FISHERY INVESTIGATIONS

The fifteenth meeting of this committee was held at the University of Toronto, Toronto, Canada, on October 22, 1928. The committee viewed with particular concern the increasing intensity of the fishing for haddock and urged the respective Governments to make at once every effort to investigate the situation thoroughly. As nearly as can be ascertained, the catch of haddock by United States and Canadian fishermen has increased from 100,000,000 pounds in 1921 to 280,000,000 pounds in 1928. Because of the possible interrelationship of the stock of haddock on the grounds off the coast of Canada with that off our own coast, the problem has international aspects, which may necessitate international accord and action. The meetings of the committee have resulted in a coordination of fisheries investigations of the several governments, a standardization of method, and the initiation of scientific research bearing directly on the economic problems of the fisheries.

PROTECTION OF GUADALUPE FUR SEALS

Recently attention has been directed toward the preservation of the Guadalupe fur seal (*Arctocephalus townsendi*). Formerly abundant on certain islands off the coast of California and Lower California, they were subsequently practically exterminated. Recently rediscovered, the matter has been brought to the attention of the Mexican Government, which is in complete accord with the idea of preserving these seals, with the result that the outlook is promising that the remnant of the herd may become the nucleus for the restoration of these animals to greater abundance.

STATISTICAL SURVEYS

According to the most recent statistics available, the commercial fisheries of the United States are in a sounder position than at any time in their history. They now employ nearly 127,000 fishermen, and the annual catch amounts to nearly 3,000,000,000 pounds, valued at about \$113,000,000. For transporting these products from the fishing grounds to market or from port to port over 4,000 persons are engaged aboard transporting vessels.

The statistical work of the bureau in 1928, as in former years, included the furnishing of statistics on the catch of fishery products, the gear employed in making the catch, and statistics of related fishery industries.

That fishery statistics, both biological and trade, are becoming more generally appreciated by those interested in our fisheries is evidenced by the generous cooperation given the bureau by fishermen, fish wholesalers, those in related fishery industries, State fisheries agencies, and others. The bureau appreciates this cooperation and wishes to take this opportunity to thank such persons for their support during the past year in an effort to give the fishing industry a statistical record upon which to base its activities. In this connection the bureau urges those in the industry to offer criticisms and suggestions for the betterment of statistics now being collected.

During 1928 unusual progress was made in the collection of statistics of the catch of fishery products in the United States. This was occasioned by greater cooperation with State fishery agencies and by the use of automobiles by agents, which enabled them to canvass a larger territory than formerly when travel was performed mainly by train. As a result, catch statistics for 1927 were obtained of the fisheries in the South Atlantic, Gulf, Pacific Coast, and Great Lakes States and for the State of Connecticut.

CANNED FISHERY-PRODUCTS AND BY-PRODUCTS TRADE

Four hundred and eighty-one establishments were engaged in canning fishery products in 1928, the total production being 15,629,980 standard cases, or 617,327,527 pounds, net weight, valued at \$95,871,855, to which may be added the value of by-products, \$14,880,956, making a total of \$110,752,811. This was an increase of 18 per cent in the value of canned products and 16 per cent in

the value of by-products when compared with the respective values of the previous year. Alaska contributed 43 per cent, California 22 per cent, and Maine 9 per cent of the total value.

FROZEN-FISH TRADE

In 1928 there were 155 public freezers and cold-storage warehouses in the United States and Alaska devoted wholly or in part to the storage of frozen and cured fishery products. The average monthly holdings during the past few years have increased, amounting to 53,925,000 pounds in 1928, or 10 per cent more than in 1927 and 22 per cent more than the 5-year average. The quantity of fish frozen, amounting to 113,637,898 pounds, is greater than the amount in any other year for which there are records.

PACKAGED FRESH AND FROZEN FISH TRADE

Packaged fresh and frozen fish were produced in 85 plants operated in 12 States in 1928. The output amounted to 65,245,376 pounds, valued at \$9,790,024. Haddock accounted for 87 per cent of the total quantity prepared. Other species packaged to a considerable extent were cod, squeteague, hake, and croaker. Massachusetts accounted for 65 per cent of the production, and Connecticut and New York also packed important quantities. Of the total production, fillets accounted for 89 per cent; the rest consisted of dressed fish, pan-dressed fish, sticks, steaks, and tenderloins.

GOLDFISH INDUSTRY

The American output of goldfish, produced in some 770 acres of ponds, mainly in Maryland, Ohio, and Indiana, in 1928 amounted to 21,500,000 fish, having a value to the breeders of about \$942,000. Of this number, 17,000,000 were common goldfish, valued at \$573,000, and 4,500,000 were fancy goldfish, valued at \$369,000.

FOREIGN FISHERY TRADE

The value of the United States' foreign trade in fishery products during 1928 amounted to \$80,028,683, of which \$58,854,938 represents the value of those imported for consumption and \$21,173,745 the value of exports of domestic fishery products. Compared with the previous year, this is an increase of 8 per cent in the value of the total trade, 6 per cent in imports, and 13 per cent in exports.

Imports consisted of 360,767,010 pounds of edible products (including fresh, frozen, cured, and canned fishery products), valued at \$37,391,079, and nonedible products (comprising mainly fish and marine-animal oils, pearls, and imitation pearls), valued at \$21,463,859.

Exports consisted of 170,817,414 pounds of edible products, valued at \$20,786,353, and nonedible products valued at \$387,392.

NEW ENGLAND STATES

As the latest general canvass of the catch of fishery products for Maine, New Hampshire, Massachusetts, Rhode Island, and Connecticut was made for 1924, no later data on general conditions in this section are available. However, the trend is revealed by statistics collected for 1928 on various phases of the fisheries in this section.

Vessel fisheries.—In 1928 landings of fish by American vessels at Boston and Gloucester, Mass., and Portland, Me., amounted to 277,981,691 pounds, as landed, valued at \$10,849,145, and were larger than in any year for which there are records; the value also was greater, due largely to the demand by the filleting trade. Of this amount, over 155,000,000 pounds were haddock. While Boston, Gloucester, and Portland continue to receive most of the fish brought in by these vessels, larger quantities are being landed at other New England ports, especially at Vinal Haven, Me., and Groton, Conn.

Mackerel fishery.—In 1928 the mackerel fishery resembled that of the previous year, with heavy southern and Block Island runs in the spring, followed by a slack season in the Gulf of Maine during the summer and autumn. An unusual run of large mackerel appeared off Cape Ann and lasted well into December. Altogether, the season's catch, amounting to nearly 31,000,000 pounds, was about 25 per cent below that of the previous year.

Packaged-fish trade.—The packaged-fish trade in New England, centering at Boston and Groton, Conn., is now on a sounder basis, and methods used at the packing plants are being modernized. The output of packaged fresh and frozen fish in New England increased perceptibly over 1927, the production in 1928 being valued at over \$9,000,000. To supply the demand for raw fish by the packers, more vessels fishing with otter trawls were added to the fleet, so that now 288 vessels of over 5 net tons are outfitted with this gear and operate from the three principal ports.

Canned sardines.—Sardine canning, conducted only in Maine in the New England section, recovered from the slump of 1927 with a production valued at over \$8,000,000.

MIDDLE ATLANTIC STATES

According to the latest statistics (1926) of the fisheries of New York, Pennsylvania, New Jersey, and Delaware, the situation is not encouraging. The production of many of the staple fish showed a tremendous decline in 1926 as compared with 1921. Notable examples are the bluefish, which declined 72 per cent; scup, 37 per cent; and squeteague or weakfish, 36 per cent.

At New York City and Groton, Conn., the landings of fresh fish by vessels of over 5 net tons amounted to about 71,000,000 pounds in 1928, which is considerably better than in 1927. As with Boston, the landings consisted largely of haddock, which are in demand by packing plants in those two cities. The menhaden industry of this section recovered very slightly in 1928.

Shad fishery.—On the Hudson River the shad fishery was carried on by 293 fishermen and yielded 79,029 fish, which weighed 246,231

pounds, valued at \$43,149 to the fishermen. This represents a decrease of 31 per cent in weight, as compared with the weight of the catch in 1927, but was nearly equal to the catch in 1926.

CHESAPEAKE BAY STATES

The last general canvass of the catch of fishery products for this region (Maryland and Virginia) was made for 1925. However, later statistics of the canning and by-products industries and certain other industries are available. The menhaden industry again suffered a poor year in 1928, the total value of the products manufactured being one of the lowest on record. The existence of this situation should encourage those in this industry to improve methods in an effort to reduce overhead and to produce a quality product. The diversion of a greater amount of menhaden meal to feedstuffs should result in a better price for this product. To produce such a product would require but little additional expenditure in improving manufacturing methods.

In 1928 greater activity was evidenced in the alewife-canning industry, the value of the products being the highest on record. The oyster industry has regained its previous level, although retail sales have not kept pace in some localities of the country. The crab industry recovered entirely from its previous poor years, and, according to reports of persons in the trade, the production was one of the largest on record. This section is rapidly becoming a factor in the production of packaged fish, especially croaker and sea trout.

Shad fishery.—In 1928 the shad and alewife fishery on the Potomac River was prosecuted by 754 fishermen. It yielded 716,420 shad that weighed 2,077,622 pounds, valued at \$214,687 to the fishermen, and 14,783,655 alewives with a weight of 5,903,062 pounds, valued at \$58,297 to the fishermen. The catch of shad was larger than in any one of the past 29 years, except 1922. The catch of alewives was larger than in any year since 1909, except 1924.

SOUTH ATLANTIC STATES

In 1927 the fisheries of North Carolina, South Carolina, Georgia, and the east coast of Florida employed 11,527 fishermen, or 14 per cent more than in 1923. The catch amounted to 260,668,693 pounds, valued at \$5,695,887, which is an increase of 14 per cent in quantity and 12 per cent in value when compared with 1923.

The fisheries of this region are conducted largely alongshore with small operating units. For this reason the trade is confined chiefly to marketing primary products, except for canned shrimp and oysters. The production of canned shrimp in 1928 showed little change over the previous year, while there was a considerable increase in the production of oysters. The output of menhaden products increased substantially.

GULF STATES

The fisheries of the west coast of Florida, Alabama, Mississippi, Louisiana, and Texas were more productive in 1927 than in any year for which there are records since 1880. They employed 15,133 fisher-

men, or 43 per cent more than in 1923, and the catch amounted to 195,705,355 pounds, valued at \$9,965,775, which is an increase of 22 per cent in quantity and 23 per cent in value when compared with 1923. This was due chiefly to larger catches of shrimp and oysters.

The production of canned shrimp was greater than in the previous year, although the market value did not increase accordingly. The production of canned oysters was about the same as in 1927.

Florida sponge fishery.—In 1928 the quantity of sponges sold on the sponge exchange at Tarpon Springs, Fla., amounted to 413,198 pounds, valued at \$729,918. Of this amount, 232,208 pounds, valued at \$623,776, were large wool; 33,744 pounds, valued at \$50,616, small wool; 61,358 pounds, valued at \$28,633, yellow; 74,698 pounds, valued at \$20,925, grass; and 11,190 pounds, valued at \$5,968, wire.

PACIFIC COAST STATES

In 1927 the fisheries of Washington, Oregon, and California produced 651,196,982 pounds of products valued at \$22,306,576, which is an increase of 25 per cent in quantity and 18 per cent in value over 1926, and is the largest catch on record. This was due mainly to larger catches of pilchards, tuna, and tunalike fishes. There were 20,514 fishermen engaged in making this catch.

In 1928 the pack of salmon was 44 per cent less than in the previous year. This was due to smaller packs of pink and humpback salmon on Puget Sound, 1928 being an off year. Compared with the previous off year, 1926, there was an increase of about 1 per cent.

The pack of sardines was the largest on record both in volume and value. The production of canned tuna was less than in 1927, but the value was greater, being slightly below the highest value on record.

Unusual developments occurred in the mackerel-canning industry of California in 1928, the production being valued at about \$1,600,000. In 1927 the production was so small that it was included in the statistics with other canned fish. Now mackerel is finding favor in the export trade with the Philippines.

Halibut fishery.—The halibut fishery of the Pacific coast, which is prosecuted by American and Canadian vessels, ranks as one of the foremost fisheries of that section. In 1928 the total weight of the catch, as landed, by vessels of both nationalities amounted to 54,915,000 pounds, valued at \$5,673,000. This is virtually the same as in 1927, and a little more than for 1925 and 1926, in spite of the depleted condition of the fishery. Of the total landings, 79 per cent was taken by American craft and 21 per cent by Canadian craft.

LAKE STATES

In 1927 the lake fisheries (Lakes Ontario, Erie, Huron, Michigan, Superior, and Namakan, Lake of the Woods, and Rainy Lake) of the United States and Canada produced 111,952,531 pounds of fish. Of the total the United States accounted for 81,326,550 pounds, valued at \$6,794,891. This is about the same as in the previous year, although there was a slight decline from the 10-year average. The average is being held up by greater catches of some of the less-

avored species, while decreases are apparent in some of the choice species, such as the cisco of Lake Erie, which shows a decline of 81 per cent compared with the 10-year average. Larger catches were made on every lake in 1927 than in 1926 except Lake Ontario, Lake Erie, and the international lakes of Minnesota. The Canadian catch amounted to 30,625,981 pounds, an increase of 11 per cent over the previous year.

MISSISSIPPI RIVER AND TRIBUTARIES

No general statistical canvass has been made for this section since 1922, therefore recent developments can not be determined. A special canvass of the fisheries of Lakes Pepin and Keokuk for 1928 reveals a smaller catch than for 1927.

TECHNOLOGICAL INVESTIGATIONS

During the past year the bureau operated the Reedville laboratory the entire year for the study of problems of the menhaden industry; a temporary summer laboratory at Erie, Pa., for the study of net preservation; another at Brunswick, Ga., to study the utilization of shrimp waste; and continued the investigation on the handling of fresh fish at Boston, Mass., throughout the year. The Washington laboratory was used mainly for the conduct of chemical and technological research. In addition, one of the bureau's technologists studied the South Atlantic and Gulf States fisheries in an effort to acquaint those in the fisheries with better handling methods. The bureau received the active cooperation of Johns Hopkins University and the University of Wisconsin in research on two important fisheries problems.

NET PRESERVATION

Work upon the perfection of a treatment for use upon cotton nets in salt water was continued, an attempt being made to ascertain the most economical treatment. It is estimated that by following the procedure outlined by the bureau the cost of preserving trap gear may be cut to about one-third the cost of the best commercial treatments employed.

The investigators at the Erie (Pa.) laboratory discovered that the deterioration of gill nets was due to bacteria alone. These are cellulose-digesting organisms, which attack the cotton fiber. In combating these destructive organisms the bureau's trap-net treatment proved effective. Formerly there was prejudice to this treatment as it darkened the nets and was believed to decrease their fishing efficiency. However, practical tests in Lake Erie raised doubts as to the soundness of this conclusion except as to the incidental catch of whitefish.

BY-PRODUCTS

Menhaden.—In the study of by-products problems special attention has been accorded the menhaden industry, not only because of the urgent need for improvement in this industry, but also because

of its similarity to the herring and sardine industries in the reduction of accumulated waste. To date two main sources of loss are apparent, namely, losses of protein and oil in the waste liquors and nitrogen loss through oxidation in the flame driers now in use. Two small-scale commercial driers were tested. One showed promise, so that a slightly altered type will be tested next year; the other showed excellent results and will be run again next season, as the supply of fish last year was not regular enough to allow the technologists to gather sufficient data upon cost and efficiency.

It is equally as important to save oil and to improve its quality as to improve meal, for both represent nearly equal portions of the profits of the menhaden industry. The presence of free fatty acid detracts from the usefulness of oil, and if present in too great quantity actually changes the channel of trade into which the oil may enter. Preliminary experiments have shown conclusively that water increases the free fatty acid content of oil in storage tanks, and that sun and rain do not improve the quality of fish oils.

Ground fish and waste fish.—As a result of the increasing demand for packaged fish large quantities of waste accumulate at central points. In addition, large quantities of trash fish are taken in the nets of otter trawls fishing for ground fish. Further, small amounts of fish waste accumulate in isolated localities or city fish markets. All of these factors make profitable utilization more feasible than in former times. The majority of this waste comes from nonoily fish having a high glue content, which renders reduction extremely difficult. Experiments looking toward the solution of this problem are now under way, special consideration being given to the development of plants suitable for installation on board fishing vessels. Larger fishing vessels now being built have space for such equipment.

Shrimp.—Through research upon the utilization of shrimp waste it has been found that fertilizer material or shrimp meal (a material particularly valuable for its mineral constituents) can be prepared by four relatively inexpensive and simple methods applicable to those localities in which the industry is small and the season short. The fertilizer stock is excellent for treating soils, and the meal promises the same favorable results that have been secured from using steam-dried shrimp meal in animal nutrition. Through the adoption of such processes it is expected that a good deal of the material now discarded will be utilized.

NUTRITIVE VALUE OF FISHERY PRODUCTS

Fishery products are by nature rich in many important food factors, as the sea lacks the deficiencies common to many land areas. Therefore these products are a most valuable adjunct to the citizens' dietary and to the farmers' list of feeds. In general, these products are particularly valuable for their mineral constituents, vitamin potency, and availability of protein. The researches of the bureau's investigators at Johns Hopkins University have added materially to this knowledge. To further increase this knowledge, the bureau has arranged cooperative feeding tests with the United States Department of Agriculture, State experiment stations, various private agencies, and independent investigators.

IMPROVED HANDLING OF FRESH FISH

The bureau's technologist on the Boston Fish Pier has done much to promote the adoption of improved practices and methods of handling fish on the pier and aboard vessels, and also is aiding the industry to draw up plans for unloading vessels more expeditiously.

The technologist working in the Southern States has been demonstrating improved methods of handling and distributing fishery products, including methods of precooling the product. During one phase of this study a chilling tank was installed at the fish freezer of a cooperating dealer in South Carolina to demonstrate possibilities along this line. Cooperation along similar lines was extended to dealers in other Southern States, particularly in Louisiana and Texas. This work has been conducted in cooperation with the fisheries association of that territory.

ALASKA FISHERIES SERVICE

ADMINISTRATION OF FISHERY LAWS AND REGULATIONS

Since the passage of the act of June 6, 1924, giving the Secretary of Commerce broad powers in regard to the time, place, and manner of conducting commercial fishing in Alaska, distinct progress has been made in restoring runs of salmon depleted in earlier years by overfishing, and in consequence there has been a healthful stabilization of the fisheries, Alaska's most important industry. The beneficial and progressive results thus achieved clearly reflect the wisdom of the constructive policy that, since the passage of the new law in 1924, has been pursued in conserving this great natural resource. The constant purpose and aim is to so conserve the fisheries that there may be a maximum use without impairment of the future supply.

The salmon fishery of Alaska extends for more than 2,000 miles along the coast, from the southerly extremity to north of the Arctic Circle. In this great region the distinct differences in geographic and other features naturally result in considerable variation in the time and extent of the runs of salmon from the sea for reproductive purposes. This, in turn, means a corresponding variation in the character and extent of fishing operations in the different regions.

The regulations issued each year are framed carefully to meet the varying conservation requirements in the 12 fishing areas created by the Secretary of Commerce, but it occasionally happens during the progress of the season that modification of the regulations becomes advisable to meet conditions arising in a particular section. The Commissioner of Fisheries was in Alaska several weeks during the active salmon-fishing season and was able to initiate immediately any such necessary changes in the regulations.

A patrol for the enforcement of the fishery laws and regulations was carried on actively throughout the season. Eleven statutory and two hundred and one temporary employees were engaged in the work, in addition to the crews of the 14 vessels of the bureau and 8 chartered boats. A number of launches were also used in the patrol. Violations of the fishery laws and regulations occurred chiefly in southeastern Alaska and were primarily failures to comply with restrictions as to closed periods and closed areas. These cases were disposed of through the courts in the usual manner.

In the general revision of the regulations issued under date of December 18, 1928, to be effective in the following season, some further restrictions were imposed in certain areas where the intensity of fishing had been too great, and various other changes were made for the purpose of preventing any marked expansion of operations. An important feature of the revised regulations was the redistricting of the southeastern Alaska area into eight divisions, instead of six as formerly. Various modifications of the regulations made by supplementary orders in the spring of 1929 included the extension northward of the boundary of the Yukon-Kuskokwim area and restrictions on commercial fishing for herring therein.

On February 28, 1929, an act was approved amending section 7 of the Alaska fisheries act of June 26, 1906, in regard to the utilization of salmon after removal from the water. Formerly it was provided that salmon must not be canned or salted for sale for food more than 48 hours after being killed, but this has now been extended to include icing, freezing, smoking, and drying for human consumption.

ALASKA SALMON HATCHERIES

At the Government hatcheries at Afognak and on McDonald Lake 44,478,925 red-salmon eggs were collected in 1928, as well as 4,429,000 pink-salmon eggs. Shipments of 2,493,000 red-salmon eggs and 3,888,550 pink-salmon eggs in the eyed stage were forwarded to Seattle in October. At the privately owned hatchery operated under the provisions of the Alaska fisheries act of June 26, 1906, 20,310,000 red-salmon eggs were collected.

SPECIAL STUDIES AND INVESTIGATIONS

Fourteen weirs for counting salmon ascending streams to spawn were maintained in 1928, as follows: Anan Creek, Olive Cove, Eagle Creek, and Situk River in southeastern Alaska; Karluk River, Chignik River, two streams tributary to Olga Bay, Uganik River, Morzhovoi Bay, Thin Point Lagoon, Chinik Creek, and English Bay in central Alaska; and Ugashik River in western Alaska. The collection of accurate data on the spawning population in a salmon stream over a period of years is an important factor in the study of the salmon to determine the size of the future run that may be expected from a known escapement. A general survey of the escapement of salmon also was made in all districts.

Extensive collections of salmon scales were made in several localities for life-history study of the salmon, and a tagging experiment was conducted on the Alaska Peninsula to develop further information concerning migration routes, 463 red salmon being tagged and released from a trap at Nicholaski Spit. Studies of the herring and clam fisheries were continued.

PRODUCTS OF THE FISHERIES

The output of Alaska fishery products in 1928 showed a decided increase, the total value representing a gain of 35.8 per cent over the preceding year and ranking third in the history of the industry, being exceeded only by the value of products in 1918 and 1926.

More canneries were operated than in any previous year, and the production of canned salmon increased from 3,572,128 cases in 1927 to 6,083,903 cases in 1928, or approximately 70 per cent. The pack of cohos increased about 18 per cent, chums 96 per cent, pinks 96 per cent, and reds 48 per cent, while kings decreased about 23 per cent. As compared with the average for the five years from 1923 to 1927, inclusive, there was an increase in the pack of every species, the gains aggregating nearly 22 per cent for the entire pack. This greater output was attributable in large measure to the extraordinarily heavy run of red salmon in the western district and to the greatly improved condition of the pink-salmon run in southeastern Alaska.

The total value of the fishery products of Alaska in 1928 was \$54,545,588, as against \$40,163,300 in 1927. In addition to canned-salmon products valued at \$45,383,885, salmon were mild-cured, pickled, fresh, frozen, and otherwise utilized, in the value of \$2,103,878. Other important fishery products were valued as follows: Herring, \$3,098,457; halibut, \$3,094,000; whaling, \$454,274; shrimp, \$202,165; clams, \$107,046; crabs, \$51,477; cod, \$28,979; and miscellaneous products, \$21,427. The value of the catch to the fishermen was approximately \$17,343,000, or \$3,531,000 greater than in the preceding year. There were 31,086 persons employed in the various branches of the industry, as compared with 28,872 in 1927.

The extent and condition of the Alaska fisheries in 1928 and of the activities of the bureau under the laws and regulations for the protection of the fisheries are covered in detail in the annual report of the Alaska service for that year.

ALASKA FUR-SEAL SERVICE

GENERAL ACTIVITIES

Computations made in 1928 indicate that the numerical strength of the Pribilof Islands fur-seal herd was seven times as great as in 1911, when the North Pacific Sealing Convention for the protection and preservation of the fur seals was ratified. The increase in the size of the herd has been reflected in larger takes of sealskins in successive years.

Sealing activities at the islands in the season of 1928 included the marking and reserving of an adequate number of 3-year-old male seals for future breeding stock, the taking and curing of sealskins, and the operation of the by-products plant on St. Paul Island for a brief period to supply food for foxes. Incidental to sealing operations, attention was given to the management of the fox herds and to the taking of fox skins.

In 1928 several new buildings, principally houses for natives, were erected on St. Paul and St. George Islands, and a medical building on the latter island was partly completed. Satisfactory progress was made in the extension of improved roads on both islands.

A staff of employees at the Pribilofs directs the work performed by resident natives and by temporary native workmen from the Aleutian Islands and the mainland, who assist with the work in the summer. The temporary labor is employed at a specified wage, but

the Pribilof natives are compensated by food, fuel, shelter, and educational and medical facilities furnished the entire native population, which at the close of the year 1928 numbered 368 persons. Additional compensation is paid Pribilof natives in cash at the rate of 75 cents for each sealskin and \$5 for each fox skin taken, and certain other small cash payments are made for special services.

The annual supplies for the Pribilof Islands were transported from Seattle, Wash., on the U. S. S. *Vega*, through the cooperation of the Navy Department. On its return to Seattle, the vessel carried the annual shipment of sealskins and fox skins, as well as a number of passengers. Assistance also was rendered by the United States Coast Guard in patrolling waters frequented by the fur-seal herd.

SEAL HERD

Computations showed a total of 871,513 fur seals in the Pribilof Islands herd on August 10, 1928, an increase of 62,643 animals, or 7.74 per cent, over the corresponding figure for 1927.

TAKE OF SEALSKINS

In the calendar year 1928 there were taken on the Pribilof Islands 81,099 fur-seal skins, of which 23,003 were from St. Paul Island and 8,096 from St. George Island. This was an increase of 6,157 over the number taken in 1927.

MARKING RESERVED SEALS

In 1928 there were marked 8,852 3-year-old male seals to be reserved for future breeding stock, of which 6,900 were on St. Paul Island and 1,952 on St. George Island. The marking was done by shearing a patch of fur, and in addition on St. Paul Island 200 of the animals so marked were also iron branded for special observation in future years. In addition to the seals marked, there remained also the 3-year-old males that were not taken up in driving operations.

SALE OF SEALSKINS

In the fiscal year 1929 two public-auction sales of fur-seal skins taken on the Pribilof Islands were held at St. Louis, Mo. The first was on October 15, 1928, when 7,174 black dyed, 5,623 logwood-brown dyed, 647 golden-chestnut dyed, and 16 miscellaneous (dressed and raw salted) skins, a total of 13,460, were sold at a gross price of \$414,103.10. At the same time 161 Japanese fur-seal skins were sold for \$1,686.70, of which 123 were dyed black, 21 dyed logwood brown, 1 washed and dried, and 16 raw salted. These 161 skins were the United States Government's share of sealskins taken by the Japanese Government in 1927 on Robben Island. There were sold also 1 confiscated skin dyed logwood brown and 4 confiscated skins washed and dried for \$35.80.

At the second sale, held on April 8, 1929, 5,334 black dyed, 9,884 logwood-brown dyed, 1 golden-chestnut dyed, and 5 miscellaneous skins, a total of 15,224, were sold at a gross price of \$469,442.50.

Special sales of sealskins, authorized by the Acting Secretary of Commerce, in the fiscal year 1929 consisted of 245 logwood-brown dyed skins at a gross price of \$12,834.87. All were taken at the Pribilof Islands.

FOXES

The feeding and trapping of foxes on the Pribilof Islands afford employment and special compensation to the natives in the winter, when sealing activities are at a minimum, and the sale of the fox skins brings considerable revenue to the Government.

There were sold at public auction on October 15, 1928, at St. Louis, Mo., 278 blue and 15 white fox skins taken on the Pribilof Islands in the season of 1927-28. The gross price realized was \$21,290.

Foxing operations in the winter of 1928-29 resulted in a take of 79 blue and 8 white fox pelts on St. Paul Island and 465 blue pelts and 1 white pelt on St. George Island, a total of 553. During the season 24 foxes on St. Paul Island and 281 on St. George were trapped, marked, and released for breeding purposes. The actual breeding reserve naturally was much greater, as many of the foxes are not caught in the traps.

FUR-SEAL SKINS TAKEN BY NATIVES

By the provisions of the North Pacific Sealing Convention of July 7, 1911, natives of the Pacific coast may, under certain restricted conditions, take fur seals at sea. The resulting skins must be authenticated as having been taken lawfully before they can enter into commerce. One thousand four hundred and eighty-one seal-skins taken in 1928 have been authenticated by the Government, 773 of which were taken in the offshore waters of southeastern Alaska and 708 in waters off the coast of Washington. Through the courtesy of the Interior Department the latter skins were authenticated by the superintendent of the Neah Bay Indian Agency. An official report states that 2,421 fur-seal skins were taken by natives of British Columbia in 1928.

FUR-SEAL PATROL

A patrol of the waters frequented by the Pribilof Islands fur-seal herd was again maintained by vessels of the United States Coast Guard. Three vessels of the Bureau of Fisheries also assisted in the work—the *Widgeon* and *Auklet* in southeastern Alaska and the *Brant* off the coast of Washington.

PROTECTION OF SEA OTTERS, WALRUSES, AND SEA LIONS

Regulations previously issued for the protection of sea otters, walruses, and sea lions were not changed during the year. The killing of sea otters is prohibited at all times. There is a closed season at all times on walruses and sea lions, although certain limited killing is permitted under specified conditions.

PROPAGATION AND DISTRIBUTION OF FOOD AND GAME FISHES

While the output in various fields and at various stations fluctuated, the aggregate output was substantially the same as that of the previous year, the total of 7,060,369,500 eggs, fry, and fingerlings representing an increase of 24,052,300 over 1928. Decreases occurring in the production of certain species were balanced by material increases in the numbers of other forms. One of the most serious shortages occurred in connection with the rescue work on the upper Mississippi River, where water conditions were such that virtually no applications could be filled from this source. Offsetting the decline, however, was the increased shad output of the Potomac River, which had been exceeded in only three years since 1900. Increases were registered in the aggregate production of the Atlantic coast marine species—cod, haddock, pollock, and winter flounder—as well as the usual quadrennial gain for the commercially important sockeye salmon. A decline was noted in the production of whitefish, lake trout, and pike perch. There follows a summary of the output classified according to the natural grouping of the propagation activities.

SUMMARY OF OUTPUT

Warm-water species:	
Basses-----	3, 243, 900
Sunfish-----	2, 154, 000
Crappie-----	1, 898, 900
Yellow perch-----	193, 111, 500
Other-----	121, 050
Cold-water species:	
Trouts—	
Brook-----	16, 855, 200
Rainbow-----	12, 728, 200
Loch Leven-----	9, 214, 700
Black-spotted-----	19, 084, 000
Grayling-----	1, 765, 000
Landlocked salmon-----	668, 700
Anadromous species:	
Shad-----	71, 351, 000
Glut herring-----	11, 500, 000
Salmon—	
Atlantic-----	917, 200
Pacific-----	152, 529, 100
Striped bass-----	9, 661, 000
Commercial species (Great Lakes and interior waters):	
Whitefish-----	97, 295, 000
Cisco-----	132, 200, 000
Lake trout-----	30, 335, 000
Pike perch-----	80, 750, 400
Carp-----	26, 831, 000
Marine species:	
Cod-----	2, 502, 155, 000
Haddock-----	351, 442, 000
Winter flounder-----	2, 918, 583, 000
Pollock-----	358, 442, 000
Mackerel-----	2, 778, 000
Miscellaneous fishes-----	52, 754, 650
Total-----	7, 060, 369, 500

New substations were placed on an operating basis at Fort Worth, Tex., and Crawford, Nebr., although the latter had not been finally completed by the close of the year. The transfer of the Potomac

River shad station from Bryans Point, Md., to Fort Humphreys, Va., was under way at the opening of the fiscal year and was completed in time to permit the gratifying hatch mentioned above. The change gives the bureau a model plant for this work. Construction work at the large new pond station at Valdosta, Ga., continued throughout the year, but was retarded by difficulties encountered in sinking wells to provide subterranean drainage. Prospects indicate that this obstacle will be overcome within a short time. Title to the sites for new pond-cultural substations at Reagan, Okla., and Creede, Colo., has been cleared and construction is scheduled to begin immediately.

Car distribution was somewhat hampered by the retirement of car No. 4 from service, but a contract has been awarded for and construction begun on a modern steel car to replace it. A large hatchery building of rustic log design has been under construction in Yellowstone Park, and rearing pools have been completed at Mammoth Hot Springs within the park. Arrangements have been made with the National Park Service whereby the bureau will furnish an investigator to study fishing conditions in the parks and direct fish-cultural operations. Attention will be given to other Federal areas, such as the national forests, and an employee will be in charge of the bureau's stations in the intermountain area.

COOPERATIVE ACTIVITIES

The bureau's relations with outside agencies, such as the States and sportsmen's organizations, have been extended. The fish-nursery system, whereby sportsmen furnish pools and ponds and rear to fingerling or adult size fish received from Federal hatcheries, has expanded, so that 114 units were in operation, which received 4,070,268 fish of various species as well as over 900,000 eggs. These enterprises have developed to an extent that has placed a severe strain upon the bureau's ability to supply fish, but it is believed that the results attained from the planting of larger fish justify extraordinary efforts. The State of Virginia inaugurated a series of such units, which were stocked with several hundred thousand trout from the bureau's Wytheville (Va.) station. Plans have been laid to fill the bureau's applications for local waters from the output of these nurseries.

There have been many other instances of mutually helpful cooperation with the States. The bureau has detailed an employee to undertake the propagation of shad in Florida and to resume the propagation of spiny lobsters, which was started last season. The usual cooperative arrangement with Pennsylvania and Vermont for the operation of the pike-perch station on Lake Champlain was continued, although extreme weather conditions seriously reduced the output of fry. The bureau has continued to assist the State of West Virginia by incubating a million trout eggs at the White Sulphur Springs (W. Va.) station for distribution within the State. The practice of assigning trout eggs to such States as desire them has been continued as far as the available supply would permit. An employee was detailed throughout the greater part of the year to supervise the construction of a hatchery for the State of Arkansas.

One of the large fishing companies requested that an experiment be made regarding the possibility of planting fertilized cod and haddock eggs taken by steam trawlers operating on the offshore banks, such as Georges. Two men were detailed on this work for about six weeks during the spring, but weather conditions prevented a full realization of all the possibilities of the undertaking. The bureau has continued the operation of a striped-bass hatchery in cooperation with the State of North Carolina. Fish-cultural activities are being expanded in Glacier National Park, the park service assisting in the initiation of egg-taking operations and in the construction of rearing pools. A limited distribution of bass and other pondfishes was obtained from a large pond at Miles City, Mont., constructed by the State and operated by this bureau on Government-owned land.

PROPAGATION OF PACIFIC SALMONS

The aggregate output in this field was 152,529,100, about 12,000,000 in excess of the previous year. The gain was entirely accounted for by an increase in the production of sockeye salmon. All other species handled showed a decline in the number distributed. As the sockeye is the most valuable form commercially, it is gratifying to note that operations with this variety were so successful. A very satisfactory season at the Alaska stations was largely responsible for this situation. A small decline in the output of chinook salmon is attributable to limitations in the collections in the Columbia River, from which field the bureau derives its main supply of this species. As usual, due to the limited capacity of the Puget Sound stations, it was necessary to discontinue the taking of chum-salmon eggs while a supply was still available. A number of the stations have been increasing their rearing-pond equipment with the object of distributing a larger proportion of the output as fingerlings.

MARINE SPECIES OF THE ATLANTIC COAST

These stations handle four species only—the cod, haddock, pollock, and winter flounder, which are distributed as fry or fertilized eggs. For the first time the output exceeded 6,000,000,000—several hundred million over that of the previous year. The increase is confined to the latter three species, the output of cod remaining virtually equivalent to that of last year. Experiments in fertilizing immense numbers of cod and haddock eggs taken in conjunction with operations of steam trawlers working out of New York City and planting them on the offshore fishing grounds were undertaken. Two employees of the Woods Hole (Mass.) station were detailed to accompany the vessels, but practical difficulties in handling the fish prevented achieving the expected results. Shore cod fisheries in the vicinity of the Boothbay Harbor (Me.) station yielded a considerable quantity of eggs for this work, however. It is interesting to note that an employee of this station was lent to the State of Florida to supervise the hatching of spiny lobsters or crawfish at Key West. This constituted the only instance in which the artificial propagation of this form has been conducted on a practical basis. The augmenting of the output of haddock was deemed especially desirable, since this species has enjoyed a rapidly increasing demand for filleting.

ANADROMOUS SPECIES OF THE ATLANTIC COAST

One of the most satisfactory features of the operations conducted by the division of fish culture was the marked increase in the production of shad at the Potomac River station. The new station at Fort Humphreys, Va., operating for its first season, handled over 78,000,000 eggs. The total distribution of over 71,250,000 shad, which included a limited number produced at the Edenton (N. C.) station, indicates a high percentage of hatch. A hatch of yellow perch almost equalling earlier records also was obtained at Fort Humphreys. Two consecutive successful seasons with the shad give reason to hope that, on the Potomac River at least, the runs can be maintained on a plane of high productivity. The Edenton (N. C.) station enjoyed average success in its shad work, but the output of glut herring was negligible in comparison with that of last year. The Craig Brook (Me.) station, obtaining its supply of Atlantic-salmon eggs from Canada, handled 500,000 less than in the previous year. A program of rearing these fish to larger size before distribution may be developed to offset any possible future decline in the numbers handled. The bureau again enjoyed the cooperation of the State of North Carolina in propagating striped bass on the Roanoke River.

COMMERCIAL SPECIES OF INTERIOR WATERS

The main activity in this field is the propagation of whitefish, cisco or lake herring, and lake trout at the Great Lakes stations. With regard to the whitefish, the reduction in the number of eggs collected, which has become so evident during the past five or six years, continued, and the output for the past year dropped below 100,000,000 fry. As the egg take and consequent distribution of fish reflect the condition of the fishery to a considerable degree, the present situation can not be viewed complacently. Virtually all of the stations handling this species reported inability to secure an adequate supply of eggs. The fluctuations that mark the cisco operations, however, brought the output up to 35,000,000 more than in the previous year.

Inability to operate on spawning grounds in Canadian waters contributed to the reduction in whitefish output at the Cape Vincent (N. Y.) station. The production of lake trout in this field was approximately 30,000,000, or 7,000,000 under last year's figures. The decline apparently was not traceable to a shortage in fish so much as to adverse weather conditions and other factors. An attempt to net and pen lake trout at Cape Vincent awaiting the maturity of the eggs failed to give the successful results that rewarded the previous season's attempt.

Operations with buffalo fish, carp, and yellow perch in interior waters were attended by average results, but there was a noticeable decline in the production of pike perch, the output totaling about one-third that of the previous year. This was due to the virtual failure of the Lake Champlain field, which is usually responsible for the bulk of the output. Rigorous weather conditions accompanying an extremely late spring proved to be a very serious handicap to egg collections. The Great Lakes stations that handle this form enjoyed a reasonably successful season.

GAME FISHES OF INTERIOR WATERS

The strictly game fishes include the trouts and pondfishes, such as bass, sunfish, and crappie, propagated at the bureau's stations in the Southern States. The only species of trout showing an increase in abundance was the black-spotted or native cut-throat of the Rocky Mountain section. The main field for work with this species in the Yellowstone National Park yielded an egg collection of well over 20,000,000. The Meadow Creek (Mont.) substation of the Bozeman (Mont.) station, one of the most important of the Loch Leven and rainbow-trout egg-collecting fields, turned in a total within 1,826,000 of its previous high record. A new rainbow egg-collecting station yielding a half million eggs was developed at Williams Lake, Idaho, in connection with the salmon work in that territory. The Craig Brook (Me.) station increased its take of brook-trout eggs from the station brood stock to a new record, and its substation at Grand Lake Stream, Me., handled almost a million landlocked salmon.

Development of the brook-trout egg-producing unit at York Pond, N. H., has continued, with a yield of nearly 3,000,000 eggs for the past season. In brief, the bureau has augmented its collections of trout eggs at the above-named stations and at others in New England, the Middle Atlantic and Middle West sections, Utah, Wyoming, and Colorado so as to become virtually independent of outside egg sources, making up any deficiencies by the exchange of surplus rainbow, Loch Leven, and other eggs for eggs of needed varieties. The bureau has likewise deliberately reduced its numerical output of trout by retaining the fish longer before planting, with consequent diminution of output. This plan, together with the distribution of larger numbers of advanced fry and small fingerlings to private rearing pools conducted by groups of sportsmen, probably will result in more efficient restocking in spite of the smaller number handled.

While the aggregate number of warm-water pondfish distributed shows a material decline from the previous year, this has been due to an absence of distribution from the rescue field on the upper Mississippi River. The output of large-mouth and small-mouth bass, which are mainly derived from the hatcheries, was about the same as the previous year, the small-mouth distribution being somewhat in excess of the previous season. Without citing the records of the individual stations, it may be said that most of them produced an average yield of bass, sunfish, and similar fishes. Development at Orangeburg, S. C., permitted a much greater distribution from that point, but the San Marcos (Tex.) station, normally of high productivity, was visited by floods, which injured the spring hatch.

RESCUE OPERATIONS

The salvaging of fishes stranded in the landlocked sloughs along the Mississippi River was an activity of no importance during the past year, the continued high stage of the river rendering such work unnecessary. Virtually no fish were seined and returned to parental waters, and no general distribution to other waters could be made. Inasmuch as the bureau can not cover the full area in which rescue work is possible in a normal year, the situation during the past season will prove beneficial, in that the river itself, serving as a reservoir, will be amply restocked.

BIOLOGICAL INVESTIGATIONS

The chief function of the division of scientific inquiry is to provide fishery administrators, both State and Federal, with sound and practical scientific information that can be applied, either immediately or ultimately, to the conservation of the fisheries. The investigations of the bureau's biologists contribute year after year to the upbuilding of a coherent body of scientific knowledge, which ultimately will become as important in the development and conservation of the aquatic food supply as have the associated branches of agricultural sciences become in the production of land crops.

Satisfying progress has been made in solving the fundamental problems encountered in the major fisheries of the entire country. In the marine fisheries of the Atlantic coast attention has been centered upon variations in the yield and the natural forces that determine abundance. In the salmon fisheries of the Pacific coast and Alaska predictions of future runs in the important areas are now becoming feasible; and the yield, at least in Alaska, is being so regulated, through protection of an adequate spawning escapement, that an abundant future supply is assured. In the Great Lakes the question of the cause of the decline of the fisheries has been investigated, and a study of fishing gear to determine the most effective and at the same time the least destructive types has resulted in definite recommendations for legislation to the various State governments. In the field of aquiculture studies on greater productivity of waste areas have been particularly successful. Hatchery methods have been improved through studies of fish diet, and the control of disease and fish production in ponds and swamp areas likewise has been increased. Through an extension of precise knowledge of the habits and physiology of shellfishes, important improvements in cultural or farming methods have been furnished the shellfish industries.

Mention has been made in previous reports of the growing public appreciation of the results of scientific investigation of the fisheries; and the greater interest, manifested by more liberal financial support, has been continued through the past year without abatement. Despite the handicap of too few permanent investigators, the activities carried on by an increasing number of temporary employees have expanded. The scientific work is now organized under three distinct heads—commercial fishery investigations, shellfish investigations, and fish-cultural investigations. Cooperation in research by State and private agencies has continued to be a material factor in increasing its extent and effectiveness.

COMMERCIAL FISHERY INVESTIGATIONS

North and Middle Atlantic States.—In the North Atlantic area data have been obtained concerning the life history and migrations of the Nantucket Shoals cod, a fish of peculiar importance to the American fishery because of its availability throughout the year. Studies on the migrations of cod have been extended southward to the shores of New Jersey and to the mouth of Chesapeake Bay, where during the past spring unexpectedly large quantities of larvæ and eggs were taken for the first time west of Rhode Island.

Investigations of the mackerel fishery were continued on a large scale. This fishery is subject to extreme fluctuations, a study of which reveals the success or failure of a spawning year as the chief cause, rather than migration, which previously had been held responsible. With the object of perfecting a system of prediction concerning the probable abundance of future year's runs of mackerel, observations on the commercial catch are being continued at the chief ports of landing, and, in addition, oceanographic investigations (referred to later) and quantitative collections of eggs and larvæ have been undertaken in order to discover not only the occurrence of a successful spawning year at the earliest possible moment but also the natural causes that favor survival. Such predictions, which already have attained practical accuracy, not only will afford material benefit to the producer, the distributor, and cold-storage interests, but may warn of depletion, should it occur, and indicate the extent to which the mackerel fishery may be prosecuted with safety.

Fishery investigations in the Middle Atlantic States, begun during the last fiscal year, have been continued, primary attention being given to the squeteague or weakfish, which is the most important species in this region. Observations also were made on the scup and butterfish as well as other minor species taken in the shore fisheries conducted largely with pound nets.

Historical records of the pound-net fishery of Long Island and New Jersey have been analyzed in order to trace the character of fluctuations in yield. Biological observations in the major fishing centers are being made to ascertain the essential features of the life history of the fish, their spawning and growth, their feeding and migrations; and continued collection of detailed statistics is expected to provide dependable evidence on the question of depletion. In addition to the observations on the Long Island and New Jersey coasts, similar studies have been made of the commercial fisheries of lower Chesapeake Bay.

Oceanographical studies have been initiated during the present year for the purpose of discovering the causes of variations in abundance of the important fishes depending upon physical environment, such as temperatures, currents, chemical composition of the sea water, and the contained microscopic life that constitutes the food for the schools of fish. The fisheries steamer *Albatross II* has furnished the means for making these studies in the waters of the Middle Atlantic region.

In addition to the collection of eggs and larvæ of the cod, mackerel, weakfish, and other shore species, studies on the movements and distribution of the plankton organisms, upon which the mackerel directly and other fishes indirectly feed, have been undertaken. Such studies give promise of explaining the apparently erratic movements of the mackerel and other plankton-feeding fishes. All of the investigations in this area have been furthered by the facilities of the fisheries biological laboratory at Woods Hole, Mass., which for most of the year serves as a base for field operations.

The final report on the biology of the New England smelt is now in process of completion, in which the details of the life history of both marine and fresh-water races are presented and further constructive recommendations for the conservation of a depleted fishery are offered.

South Atlantic and Gulf States.—Except for important oyster investigations throughout the South, investigations of the commercial fisheries of the South Atlantic and Gulf States have centered at the fisheries biological laboratory at Beaufort, N. C., during the past fiscal year. Due to changes in the method of conducting fishery research, which lessened the usefulness of the Key West station (authorized by an act of Congress on March 1, 1911, but never completed), authorization was obtained from Congress on April 29, 1929, to return the property to the original owners. Investigations of the Texas shore fisheries were completed early in the year, and an extensive report, outlining the biology of the important species and containing constructive recommendations for fishery legislation, was published.

At the Beaufort laboratory extensive repairs and alterations to the station buildings and grounds to fit them for year-round investigations have been under way. The larval and postlarval development of the important fishes is the least understood field in fishery biology, and the peculiar advantages of situation and equipment at this laboratory have been utilized throughout the year in this important research.

With the completion of a new nursery house for the raising of the animals under controlled conditions, terrapin culture at the Beaufort station again became an active field for investigation. Although practical methods have been developed and production on a commercial scale has been carried on with the cooperation of the North Carolina conservation department, the relatively high mortality of winter-fed young terrapin has proved to be a serious obstacle. The occurrence of certain diseases was investigated; and although the nature of the diseases still remains unsolved, experiments on feeding were again undertaken with considerable success.

Pacific coast and Alaska.—One of the most important problems in the administration of the salmon fishery of Alaska is to determine, as accurately as possible, the product in terms of adult commercially valuable fish of known escapements to the spawning grounds in order that the salmon runs may be maintained at their maximum productivity. Special attention has been given during 1929 to a study of the production from known spawning escapements in the Karluk and Chignik Rivers. As the mature fish return to spawn at different ages several years are required to assemble the data for a single generation. These are now complete for the escapements of 1921 and 1922. Studies at Karluk of the number of seaward migrants leaving the stream each year are being made as a further step in determining the proper relation that should be maintained between the catch and spawning escapement. The relative fluctuations in the rate of mortality of the young fish in fresh waters and in the ocean can then be determined, in the hope that accurate forecasts of future runs may be made.

A detailed study of the statistics of the salmon fishery of Alaska, begun in 1925, has been continued during the past fiscal year. The results are proving to be of value in detecting depletion, and doubtless will be of still greater value in future years as a means of determining the effect of such regulations as have been and will be imposed. The first report of a series dealing with the statistics

of Bristol Bay and the Alaska Peninsula was published during the year.

Adding to the considerable list of tagging experiments already completed to determine the routes of migration of the spawning fish in the sea, one new experiment was conducted in the Alaska Peninsula region to determine the distribution of red salmon taken in a locality previously unfished. A report on this experiment is nearing completion.

Since 1916 an extensive series of experiments involving the marking of young salmon liberated from the hatcheries has been conducted on the Columbia River. The chief problem has been to discover the relative value of various methods and procedures of hatchery practice. A report was completed and published during the year, dealing with experiments in which young chinook salmon were marked. Another report, dealing with experiments in which young sockeye were marked, is well along toward completion.

The herring fishery is second in importance among the fisheries of Alaska, being exceeded in yield only by the salmon fishery. The rapid development of this fishery and indications that depletion has already taken place make it important to study the biology of the fish and the changes in abundance in each locality in order that proper regulations may be drawn up. This study, begun in 1925, has been continued, and an extensive report has been completed for publication.

For years the great salmon industry of the northwest has suffered from the loss that occurs when young fish, on their migration to the sea, enter irrigation and power-diversion canals and are destroyed. Further loss of fish life is occasioned when the mature fish, journeying upstream to spawn, encounter obstacles to their progress, such as dams and the tailraces of power houses, over or around which adequate fishways have not been built. Congress provided a special appropriation at the end of the fiscal year 1928 for an investigation of means for reducing this loss by devising and erecting suitable screens, stops, or diverters at the mouths of such canals or tailraces, and by devising suitable fishways over dams. Gratifying progress in this work has been made during the past year. The entire area in which such irrigation canals are operated has been surveyed, experiments were made with types of screens at present in use, and detailed studies of the use of an electrical field in stopping or diverting fish from the entrances of such canals were made, with the result that an approved type of electrical fish screen was selected, and several installations on Government irrigation projects have been made.

Inland waters.—The most important commercial fisheries of inland waters are supported by the Great Lakes; but in certain of the lakes, particularly in Lake Erie, depletion of the more valuable species is becoming acute. During 1928 a general survey of Lake Erie fisheries was completed. On the basis of data collected for these studies, the bureau has been able to assist intelligently and effectively in the recodification of the major part of the commercial fishery laws in Michigan, Ohio, and Indiana. Similar assistance has also been given New York and Wisconsin in an effort to establish uniform regulations governing the commercial fishery activities on each of the Great Lakes.

The bureau has received extensive cooperation in fisheries investigations of Lake Erie from the States of New York, Ohio, and Pennsylvania, the Province of Ontario, the Buffalo Museum of Science, and the Buffalo Health Department. Fundamental studies of the productivity of the lake, and especially environmental conditions affecting fish life, are being given chief attention by this group of investigators.

The usual cooperation with the Wisconsin Geological and Natural History Survey in limnological studies of lakes in northern Wisconsin has been continued. Notable contributions to fishery science have been made during the year by the publication of two reports covering work of several years past, one dealing with the taxonomy of the whitefishes of the Great Lakes system and the other with the life history of the herring of Lake Huron.

SHELLFISH INVESTIGATIONS

Oysters.—In the field of practical oyster culture, studies on the production of seed oysters were continued at Milford, Conn., and Onset, Mass., developing to greater effectiveness the method of catching oyster seed on shells contained in wire bags planted in the water at varying depths. In the Long Island Sound region a method has been evolved whereby the time of spawning and setting can be predicted one month in advance, so that oyster farmers are enabled to take advantage of best setting conditions by planting the cultch at the proper time of year.

Experiments in oyster farming were continued in the waters of Georgia and begun in Texas, with the cooperation, in both cases, of the State commissions. Various methods employed in northern waters are being adapted to local conditions in the South, with the expectation of demonstrating and popularizing this important form of water farming. Experimental work has been undertaken, also, to determine the factors that control the development of eggs and sperm in the oyster, which, in turn, influence the abundance of the new crop. It is expected that such detailed studies will provide a scientific basis for the development of better methods of oyster culture.

At the request of the Maryland fish commissioner, a survey was made of the natural oyster bottoms of the Potomac River. The bottoms were found to be in a deplorable state of depletion, and recommendations were made for their rehabilitation. A second survey of oyster bottoms in Mobile Bay, Ala., was made at the request of the conservation department and the Mobile Chamber of Commerce. It was found that oysters of that region were very generally destroyed by unusual flood conditions, and a program of rehabilitation was outlined.

During the fall of 1928 a general survey of the oyster problems of the Pacific coast was made, and a complete analysis of the situation was submitted for publication. Special attention was directed to the importation of the Japanese oyster, together with possible pests that might have a serious effect upon native oysters, and a program of field and laboratory investigations to increase and improve Pacific

coast oyster production has been undertaken in the Puget Sound area.

Further studies on the control of the oyster drill, which has proved to be a serious pest in lower Chesapeake Bay, were undertaken at the Beaufort (N. C.) laboratory. A complete report on this investigation has been submitted for publication, outlining the biology of the organism and recommending means of control.

Fresh-water mussels.—The pearl-button industry of America depends upon an adequate natural supply of fresh-water mussels, a mollusk that formerly grew abundantly throughout the bottom areas of the Mississippi River. Crude methods of artificial propagation employed by the bureau until the present time have been unable to maintain a natural supply sufficient to meet the growing demand. Experimental methods of propagating the fresh-water mussels recently developed at the Fairport (Iowa) laboratory, in which the parasitic larval stage in the development of the mussel is eliminated by means of culture in nutrient solutions, have been perfected during the present year and are now ready for large-scale application.

One of the first obstacles, however, to restocking the depleted mussel beds is the increasing menace of pollution in the Mississippi and tributary rivers. In many extensive areas pollution has been found to be so severe that juvenile mussels produced by artificial propagation were unable to withstand the unfavorable conditions when planted in areas that were otherwise favorable. At the end of the fiscal year detailed surveys of the various streams flowing into the Mississippi River and the Gulf were being undertaken in order to discover localities more suitable for producing abundant supplies of mussel shells. At the same time additional experiments to perfect minor points of technique are being conducted, and mussel propagation is being carried on at the Fairport laboratory on a semilarge-scale basis, the product to be planted in the few areas known to be suitable.

FISH-CULTURAL INVESTIGATIONS

All of the major projects of investigation pertaining to fish-cultural operations mentioned in the report for 1928 have been continued in the past fiscal year.

Experimental work at the Pittsford (Vt.) experimental hatchery during 1928 was concerned chiefly with feeding of fingerling and yearling trout. The primary object was to investigate the feasibility of using various substitutes for fresh meat as a food for trout. Our experiments have shown that a number of dry products are available which can be successfully substituted to replace approximately 50 per cent of the fresh meat at a very considerable reduction in cost.

The experiments on the propagation and rearing of bass and other pondfishes at the Fairport station have given very encouraging results and have shown conclusively that young bass can be reared in nursery ponds during the summer with comparatively small losses.

In the upper Mississippi wild life and fish refuge detailed studies on the natural fauna in the various sloughs, ponds, and creeks of the Mississippi River bottom were made as a basis for undertaking

fish culture on a large-scale, semicontrolled basis. The relation of the food eaten by the fish to the total amount of food available in a number of representative sloughs of the refuge was investigated carefully and a report submitted during the past spring. A number of sloughs have been cleared of brush and vegetation and seined to remove predatory fish in preparation for active fish-cultural experiments. Bass and other important game fishes will be reared and distributed or allowed to disseminate naturally through the adjacent water areas.

Investigations at the Pittsford station on diseases of trout have shown that the disease commonly known as fin rot is due to a bacterial infection, and methods of controlling it have been devised. The bureau's pathologist has rendered valuable services at the various State and Federal hatcheries throughout the year by making diagnosis and recommending treatments where epidemics of disease have occurred.

VESSEL NOTES

From July 1 to November 28 the steamer *Albatross II* was engaged in fish-tagging and other fishery investigations on the fishing banks from Cholera Bank off New York to Roseway Bank off Nova Scotia, and during this period 4,257 fish were tagged and liberated. From December 1 until February 18 the vessel was at the Boston Navy Yard undergoing necessary repairs and having a new radio outfit installed. During the remainder of the year mackerel investigations were continued and one fish-tagging cruise was made. During the year 165 oceanographic stations were made and four lines of drift bottles were run out. The vessel cruised 11,341 miles.

The steamer *Phalarope* was employed as a tender for the Woods Hole biological station and on the Potomac River in connection with shad propagation. The steamer *Shearwater* was engaged in fishery investigations on Lake Erie, besides her fish-cultural work at the Put-in-Bay (Ohio) station.

Fifteen vessels of the Alaska service cruised more than 120,000 nautical miles in the fiscal year 1929, as compared with about 90,000 miles covered by 14 vessels in the previous year. The *Brant* and *Eider* each covered approximately 14,000 miles, and the *Crane* about 13,000 miles.

An addition to the Alaska fleet was the *Coot*, a vessel 50 feet in length and 11 feet in breadth, constructed at Bellingham, Wash., in the spring of 1929 and shipped by commercial steamer to St. Michael, Alaska. It is to replace the *Tern* on the Yukon River, the sale of which vessel has been authorized.

The *Eider* continued as local tender for the Pribilof Islands, with base at Unalaska. Before the close of another season it is expected that this vessel will have been replaced by a new and larger vessel, to be named *Penguin*, which is to be constructed soon at Seattle.

The *Widgeon*, *Murre*, *Auklet*, and *Petrel* were engaged in fishery protective work in southeastern Alaska throughout the season. Other vessels employed in that district for a time in the fall, after the close of fishing operations to the westward, were the *Crane*, which had been on duty in the Alaska Peninsula following its initial voyage to

Bristol Bay with bureau employees and supplies; the *Teal*, which had patrolled waters of the Cook Inlet area during the summer; and the *Kittiwake*, engaged in the Seward-Katalla district until the end of August. The *Blue Wing* and *Red Wing* were engaged in patrol work in the Kodiak-Afognak district; the *Merganser* in the Ikaton-Shumagin region; the *Ibis* at Chignik; the *Tern* on the Yukon River; and the *Scoter* on Bristol Bay.

The *Brant* was used in southeastern Alaska during much of the season, chiefly in connection with general supervisory work by Commissioner O'Malley. One cruise was made westward as far as Kodiak in July. Secretary of Agriculture Jardine and Solicitor General Mitchell were aboard the *Brant* during part of August.

In addition to work in connection with the conservation of the fisheries in Alaska, the *Brant* was engaged for several weeks in the spring in patrolling waters of Neah Bay, Wash., and vicinity to enforce the laws for the protection of the fur-seal herd during its migration northward. The *Auklet* performed similar duty off the coast of southeastern Alaska.

During the winter several of the Alaska vessels were given a general overhauling, the work being done at Seattle and at other ports in the Pacific Coast States and Alaska. The *Scoter*, which has been employed in the Bristol Bay area for a number of years, proceeded to Seattle at the close of the 1928 fishing season and was extensively remodeled. The *Red Wing*, used in the Kodiak region, was equipped with a 3-cylinder gas engine and new tanks were installed.

On June 30 the floating equipment of the bureau consisted of 4 steamers, 4 auxiliary schooners, and 76 motor vessels ranged in size from 101 to 20 feet in length.

APPROPRIATIONS

Appropriations for the bureau for the fiscal year aggregated \$2,092,108, as follows:

Salaries	\$803, 708
Miscellaneous expenses:	
Administration.....	4, 400
Propagation of food fishes.....	503, 000
Maintenance of vessels.....	152, 500
Inquiry respecting food fishes.....	108, 000
Fishery industries.....	55, 000
Protecting sponge fisheries.....	2, 500
Protecting seal and salmon fisheries of Alaska.....	367, 000
Upper Mississippi wild life and fish refuge.....	25, 000
Repairs and improvements:	
Fish hatchery, Saratoga, Wyo.....	18, 000
Fish hatchery, Northville, Mich.....	25, 000
Fish hatchery, Bryans Point, Md., transfer to Fort Humphreys, Va.....	8, 000
Biological station, Beaufort, N. C.....	20, 000
	2, 092, 108

Very truly yours,

HENRY O'MALLEY,
Commissioner of Fisheries.

LIGHTHOUSE SERVICE

DEPARTMENT OF COMMERCE,
BUREAU OF LIGHTHOUSES,
Washington, July 1, 1929.

The honorable the SECRETARY OF COMMERCE.

DEAR MR. SECRETARY: In response to your request I furnish the following report upon the work of the service during the past fiscal year:

MORE IMPORTANT ACTIVITIES OF THE LIGHTHOUSE SERVICE DURING THE YEAR

The most important work in progress during the year was the construction of the primary light and fog signal on Lansing Shoal, near the northern end of Lake Michigan, which was nearly completed, and was placed in commission during the fiscal year, and the lightship was withdrawn. The similar station at Poe Reef, Mich., in the Straits of Mackinac, will probably be placed in commission in the early part of the fiscal year 1930. The improvements of the aids at Milwaukee Harbor, Wis., were completed. Other important aids to navigation completed or in progress during the year included the installation of a modern fog signal at Cape Cod Light Station; and at Cape Cod Canal Breakwater Light; the construction of a modern light and fog-signal station at Michigan and Gull Islands in Lake Superior; improving aids to navigation in St. Marys River; a light and fog-signal station at Muskegon South Breakwater, Mich.; improving aids in Grays Harbor, Wash.; improving aids to navigation in Columbia River; establishing a system of aids in Wrangell Narrows, Alaska; improving aids at Southwest Pass, La.; the replacement of obsolete steam fog signals in the eleventh and twelfth districts; and extensive repairs and replacements of hurricane damage in the southern districts. Works were completed or are in progress at several of the lighthouse depots, including the rebuilding or improvement of wharves, bulkheads, shops, storehouses, etc.

Six lightships with Diesel electric propulsion and two small tenders were in course of construction under contracts.

During the fiscal year there was a net increase of 394 in the total number of aids to marine navigation maintained by the Lighthouse Service. On June 30, 1929, the total number of marine aids was 19,001.

Important improvements in lighthouse depot facilities have been initiated. New locations for existing depots have been authorized at Portland, Me., and Newport, R. I. A depot at Seattle, Wash., has been acquired by transfer of Government property. A small depot at Rockland, Me., has been authorized. An excellent site for the transfer of the depot at Chicago, Ill., has been acquired from the city by exchange of properties and has been occupied.

During the year 123 new automatic marine lights on fixed structures were established and 54 lights were changed from attended to automatic. At the end of the fiscal year the total number of automatic lights on fixed structures was 1,467 (not including some partially automatic), and in addition there were 942 buoys with automatic lights, or a total of 2,409 in the Lighthouse Service. There are also 13 fog bells operated automatically.

The radiobeacon system was further extended and the effectiveness and amount of service was increased during the year. Ten additional radiobeacons were established and 12 stations were under construction. The total number in operation at the end of the year was 64. Radiobeacons for the two approaches to the Panama Canal were planned, to be installed this summer. Systematic arrangements for the elimination of interference between radiobeacons were put into effect with successful results. These include synchronization of adjacent stations through automatic clock control to prevent overlapping, and the use of different frequencies for adjacent groups of stations. Charts showing full information regarding radiobeacons were published. The number of clear weather operating periods was increased.

Considerable progress was made during the fiscal year in extending airway facilities throughout the United States. About 4,266 additional miles of airways were lighted, covering 17 different routes, as follows: Cincinnati-Chicago, Kansas City-Omaha, South Bend-Kalamazoo, Chicago-Twin Cities (La Crosse-Twin Cities section), Cleveland-Albany, Miami-Atlanta (Jacksonville-Atlanta section), Salt Lake-Pasco (Salt Lake City-Boise section), Kansas City-St. Louis, St. Louis-Evansville, San Francisco-Seattle (Redding-Seattle section), Atlanta-Chicago, New York-Montreal (New York-Albany section), Michigan Airways, Milwaukee-Green Bay (Milwaukee-Fond du Lac section), St. Louis-Columbus (Indianapolis-Dayton section), Los Angeles-Albuquerque (Gallup-Albuquerque section), Albuquerque-Wichita (Albuquerque-Clovis and Waynoka-Wichita sections). At the close of the year 10,183 miles of airways were provided with aids to navigation, including 1,406 lighted beacons and 7 radio ranges. Constant progress is being made in the improvement of air navigation facilities.

A representative of the Lighthouse Service was present at the meeting of technical committee for buoyage and lighting of coasts, of the League of Nations, held in Genoa, February, 1929, and took part in its deliberations.

Statements covering the works above mentioned in greater detail and including various other works in hand during the year are included under the appropriate heads following.

AIDS TO NAVIGATION

During the year various improvements in aids to marine navigation have been made: Forty-nine fixed lights were changed to flashing or occulting; the illuminant of 1 light was changed to incandescent oil vapor; the illuminant of 56 lights (including 16 lighted buoys) was changed to acetylene; the illuminant of 9 lights (including 1 lightship) was changed to electric incandescent; 10 radiobeacons were established; 1 gas-operated fog signal was installed at a light station; and 7 diaphones and 8 oscillators and nautophones were established at

important stations. The discontinuance of aids is under investigation from time to time as the original necessity for their maintenance ceases; 807 aids to navigation of various classes were discontinued. The total number of marine aids at the end of the year was 19,001.

In Alaska 44 new aids were established, and the total number is now 821, including 306 lights, 25 gas buoys, 3 radiobeacons, 14 other fog signals, 297 buoys, and 176 daymarks. A radiobeacon was established at Sentinel Island Light Station, Alaska, December 14, 1928.

The aids to navigation in the outlying United States territory of Guantanamo Bay, the American Samoan Islands, and the island of Guam are maintained under the supervision of the naval commanders by means of allotments made from appropriations for the Lighthouse Service.

At the close of the year there were 10,183 miles of lighted airways in operation, with 263 intermediate landing fields, 1,406 airways beacons, 164 airways weather reporting stations, 27 airways communication (radio) stations, and 7 radio range beacons. Teletype circuits for transmission of hourly weather reports were installed for experimental purposes during the year between weather reporting stations on the Chicago-New York and Los Angeles-San Francisco Airways. The experiment has shown that this system is of much value and arrangements have been made for its continuance.

The unusually severe hurricane in September, 1927, caused considerable damage to aids to navigation and other lighthouse property in Porto Rico and on the Florida coast. During this hurricane the Cape Lookout Lightship parted her moorings and was dragged from her station, but was returned within 24 hours without damage. An appropriation of \$129,934 was provided for repairing damages caused by this hurricane. A severe storm swept Lakes Erie and Ontario on April 1, 1929, causing damage to lighthouse property, the most serious being to the riprap protection at Ashtabula Breakwater, Ohio.

The airways division of the Lighthouse Service has found the inspection of airways aids to navigation by plane to be practicable and convenient.

ENGINEERING CONSTRUCTION

The more important construction projects completed during the fiscal year stated in order of districts are as follows: Extensive repairs to Little Diamond Island Lighthouse Depot wharf, Me.; installing modern fog-signal equipment at Cape Elizabeth Light Station, Me.; installing modern fog-signal equipment at Cape Cod Light Station, Mass.; relocating the tower and installing a modern fog signal at Cape Cod Canal Breakwater Light Station; improving 3 lights in Sheffield Harbor and Norwalk River; improving 4 lights in Stamford Harbor, Conn.; rebuilding Port Chester Channel Light, Conn.; establishing 5 lights in the Housatonic River, also establishing and converting 9 acetylene lights in the Hudson River, N. Y.; rebuilding the south wharf and retaining wall at Edgemoor Lighthouse Depot, Del.; rebuilding the north end of the wharf at the lighthouse depot, Lazzaretto, Md.; installing a modern fog-signal equipment at Cape Henry Light Station, Va.; and establishing Worton Point Light. Many items of repair and replacement caused by hurricane damage have been completed in the southern districts. An automatic acetylene

lighting system at Navassa Island, Caribbean Sea; installing fog-signal equipment at Tawas, Huron Island, and Big Bay Point Light Stations, Mich.; establishment of West Neebish Channel Leading Light; new structure at Fighting Island South Channel Range Light, Mich.; establishment of modern fog signal at Round Island Light Station, Mich.; new steel tower at Grand Marais Harbor of Refuge, Mich., and establishment of modern fog signal at Au Sable Light Station, Mich.; improvement of aids in Milwaukee Harbor, Wis.; establishing a light and fog-signal station with radiobeacon at Lansing Shoal, Mich.; establishment of a modern fog signal at Two Rivers Pierhead Light Station, Wis.; also at Menominee Pierhead Light Station, Wis.; the establishment of a system of aids in Wrangell Narrows and Dry Strait, Alaska; extensive improvements to aids in Columbia River, Oreg.; improvements in Grays Harbor, Wash.; establishment of Nawiliwili Harbor Breakwater Light, Hawaii; and construction of a new concrete wharf and bulkhead at Honolulu Lighthouse Depot, Hawaiian Islands.

Important works in active progress but not completed at the end of the fiscal year are as follows: Establishing acetylene lights in Inland Waterway, Norfolk, Va., to Beaufort, N. C.; repairing hurricane damage at Cove Point Light Station, Md., Havre de Grace Light, Md., and Turkey Point Light Station, Md., construction of a double dwelling for the assistant keepers at Jupiter Inlet Light Station, Fla.; iron light structures at Cape Florida Shoal, Mosquito Bank, and Hen and Chickens Shoal Lights, Hawk Channel, Fla.; repairing aids on Inside Route Atlantic and Gulf coasts, Fla.; establishing range lights in Tampa Bay; repairs to Mobile Point Light Station, Ala.; construction of Southwest Pass fog signal, La.; repairing hurricane damage at Mona Island Light Station, P. R., at the lighthouse depot, San Juan, P. R., at Port San Juan, Cape San Juan, Arecibo, and Hams Bluff Light Stations, and Yabucoa range beacons and Catano and Anegado range lights, P. R.; new keepers' quarters, Cleveland Light Station, Ohio; new light and fog signal at Poe Reef, Mich., and Fourteen-Foot Shoal, Mich.; rebuilding light station at Michigan Island, Mich.; improving aids in St. Marys River, Mich.; installing modern fog signal and equipment at Forty-Mile Point Light Station, Mich.; establishing an automatic light at Gull Island, Mich.; installing modern fog signal and machinery at South Fox Island, Mich.; reconstruction and rearrangement of aids to navigation at Frankfort, Mich.; reconstruction and rearrangement of aids to navigation at Muskegon, Mich.; establishing miscellaneous aids in Alaska; improving aids in Columbia River; improving aids in Grays Harbor, Wash.; extensive improvements at Goat Island Depot, Calif.; establishing a light station at Anacapa Island and an automatic light on Santa Barbara Island, Calif.; construction of a lighthouse depot at Honolulu, Hawaii.

IMPROVEMENTS IN APPARATUS AND EQUIPMENT

Materials have been ordered for equipping all remaining radio-beacons having spark transmitters with modern tube type radio transmitters. Designs of tube-transmitter equipment were improved so as to assure greater frequency stability. A continuous-wave radio-beacon transmitter was built and tested, indicating that this type is practicable and can be adopted when older models of the ship type

radio compasses are altered so as to be able to receive continuous-wave signals. This form of transmission will have advantages in conserving space in the crowded frequency band allotted to aids to navigation. Definite progress has been made in the reduction of mutual interference of radiobeacons. This improvement is attained by three methods: Clock control, grouped stations, and staggered frequencies. Reliable clocks have now been designed which will select a definite minute for each station in a group of three and cause that station to send its signal at that time only. This clock control makes possible the grouping of three stations with the same frequency. This permits a more widely separated frequency between adjacent groups. Reliable control clocks now available make possible the increased use of automatic or semiautomatic radiobeacons, starting and stopping the radiobeacon transmitters and associated equipment at prescribed intervals without constant personal attention, greatly increasing the efficiency of this system without increase of personnel.

At Cape Henry, Va., there was put into commission in May, 1929, the first synchronized radiobeacon and air fog signal, the latter an electric oscillator. This arrangement permits a navigator to closely estimate his distance in fog, without special receiving equipment; tests showed it to be effective to moderate distances.

The continued development of improved airways lighting equipment and accessories progressed, with the incorporation of a new type cover glass and stray light shield for the standard 24-inch revolving searchlight. Prisms are incorporated in the new type cover glass, which deflect 20 per cent of the light upward from the main beam and distribute it through 25° of vertical arc. Mercury contactors, replacing the magnetic type, have been adopted as standard for course light circuits in the beacon base. The new type stray light shield is in the form of a cylindrospherical reflector and is placed directly in front of the light source, gathering the stray light and reflecting it back to the parabolic mirror, increasing the horizontal width of the main beam. The illuminated wind indicator is improved by the use of a 150-watt bulb instead of the 75-watt bulb, and a skeleton frame is now used which provides greater visibility of the lighted cone.

During the year the improvement of airways radio equipment and communication stations progressed with the standardization of a 200-watt intermediate frequency combination telephone and telegraph transmitter, complete with motor generator line amplifier and 2-button microphones for broadcasting by voice or code to airplanes and ground stations. Standard radio buildings at 11 sites on the Transcontinental Airway were erected and equipped with standard radio apparatus to replace the old buildings equipped with obsolete arc-type apparatus. The aural type radio range beacon was improved and standardized and 7 were placed in operation during the year. Two Airways Division airplanes were equipped with up-to-date radio apparatus to check the operation of radio equipment on airways. Progress was made on the development of a polydirectional radiobeacon, designed to furnish 12 radio-marked courses, instead of 4 marked courses produced by the present radio range beacon. As the airways work will be covered more completely elsewhere in the Secretary's report, only brief references to it are included here.

Electricity is being increasingly used to furnish illuminant in light-houses and for power for operating fog signals. The extension of

commercial power lines, the design of dependable small generators, and the increase in radiobeacon installations have made it practicable and economical to further materially increase electrically lighted aids to navigation. The number of minor lights provided with electric illuminant, the current for which is supplied by a battery of primary cells or dry cells, has been much increased. Several types of flashing mechanisms for such lights are now in successful use throughout the service.

The design of an electric lamp suitable for use with the large lenses is an important problem. Several different types of lamps have been made and tested in actual service with favorable results. The improvement of lighting equipment on lightships is being studied.

Important tests of fog-signal apparatus have been carried out during the year, with results of great value. Practical tests have been made to determine the most efficient type, shape, and position of resonators for air signals. Tests of signals in which the sound is propagated by the vibrations of a circular disk electrically energized have proved satisfactory. Several of these oscillators are now in use. Satisfactory tests have also been completed of another type of vibratory-disk instrument in which the vibrations are set up by air under high pressure impinging on the center of the disk while the periphery is held rigid. Two installations of this type have been placed in service satisfactorily. During the past year important modifications have been made in the reciprocating piston type of fog signal or diaphone, increasing the volume of tone with less consumption of air.

A new type of multiple valve for whistling buoys was designed and has proved more efficient than the old type.

Daylight range lights have been established to mark an important channel in New York Harbor and have been found to be very effective in haze when unlighted ranges became useless.

The extension of automatic lighting apparatus is increasing annually, as stated earlier, adding greatly to the economy and efficiency of the service.

The number of old steam power plants for fog signals in the service is being gradually reduced; 6 such replacements were made during the year, and others are being replaced.

A new type of power boat, for buoy work, designed in the third district, is very efficient in handling small buoys. This boat is carried on the deck of a larger tender and operates in waters too shallow or restricted for a larger vessel.

ADMINISTRATION

The general organization of the service remained unchanged during the year.

The continued extension of automatic apparatus for operating lights, the grouping of minor lights under the care of fewer attendants, and the discontinuance of unnecessary aids where this can be done without detriment to the requirements of navigation have made possible a reduction in the salary expenses for light stations. There is a saving in maintenance resulting from the replacement of two lightships with fixed structures. A third will be replaced the coming year.

The act of February 25, 1929, contains various provisions of legislation affecting the Lighthouse Service, including the authorization of two aids to navigation in the approaches to the Panama Canal from the Pacific Ocean; the authorization of the purchase of depot sites at Newport, R. I., Portland and Rockland, Me., the detail of engineers of the field service to duty in Washington, and the extension of facilities for medical attention for light keepers. The acts of December 15 and 21, 1928, provide for the transfer of several reservations or portions of reservations.

A conference of superintendents of lighthouses, coast and Lake districts, was held in Washington, in January, 1929, this being the 10th of such conferences. There was valuable discussion of the entire work of the Lighthouse Service, both technical and administrative.

Superintendent King, of the fifth lighthouse district, represented the Lighthouse Service of this country at a meeting of a committee on uniformity of buoyage and lighting of the coasts, held at Genoa, Italy, February 8 to 15, 1929. A delegation, consisting of Commissioner Putnam and Superintendent Yates of the third district and Superintendent Rhodes of the eighteenth district, represented the United States at the International Lighthouse Conference in London in July, 1929.

The total appropriations for the maintenance of the Lighthouse Service for the fiscal year 1929 were \$9,685,020 and for special works \$1,851,934. Of this amount \$129,934 was a deficiency appropriation for hurricane damage. These amounts are exclusive of appropriations for airways, which amounted to \$4,659,850.

A revised edition of the regulations for uniforms in the Lighthouse Service was issued.

A new edition of the Ship's Medicine Chest and First Aid at Sea, published by the United States Public Health Service, has been furnished to vessels and light stations in the Lighthouse Service as needed.

There has been effective cooperation with other branches of the Government in many ways. The personnel on vessels and at stations are encouraged to render aid to those in distress. Cooperation with local school authorities has aided in providing school facilities for the children of light keepers at isolated light stations.

Systematic inspections of the service, both on its technical and its business sides, were continued during the year. The superintendent on general duty made general inspections of stations, vessels, depots, etc., and the examiner made examinations of the office business methods and accounts, depot stores, and other property records in various lighthouse districts. Special inspections were made by the Commissioner and other officers from Washington.

A cost-keeping system based on actual expenditures for the various features, including direct purchases and articles issued from depot stocks, was continued in effect throughout the fiscal year. A stock record was also maintained.

PERSONNEL

On June 30, 1929, there were 5,773 persons employed in the marine work of the Lighthouse Service. This is a reduction of 92 from the number in 1928, and of 247 from the maximum number in 1923.

There has been a steady increase in the number of aids to navigation maintained, and this continual decrease in personnel is due to the increasing use of automatic apparatus.

The number of persons in the airways division on June 30, 1929, was 1,180, making a total of 6,953 for both branches.

The United States Employees Compensation Commission give the number of reported cases of injury subject to compensation for the calendar year 1927 of employees of the Lighthouse Service as follows: Cases resulting in death, 3; cases resulting in permanent total or partial disability, 10; cases of temporary total disability, 143. Four cases of accidental death by drowning of employees on lighthouse vessels occurred during the fiscal year, and 1 death was caused by an explosion on a tender. There were more than 300 casualties resulting in more or less serious injuries of employees on vessels and at light stations, etc., during the year.

Medical treatment by the Public Health Service, without charge, was received by approximately 1,505 employees of the Lighthouse Service during the fiscal year.

Incidental to the regular work of the service, many opportunities arise for rendering aid to those in distress because of the location of light stations and vessels. During the fiscal year about 80 instances were reported of saving life and property or rendering valuable aid, often at great risk to the Lighthouse Service employees. Many of these acts were especially meritorious, and some of the employees were specially commended by the Secretary of Commerce.

LIGHTHOUSE DEPOTS

Lighthouse depots conveniently located and adequately equipped are essential in this work. Some depots have become inadequate both in area and equipment, others are in locations where they can not be utilized efficiently. Provision should be made for new depots in several districts and for improvement and enlargement of some depots now in use. Considerable progress has been made during the fiscal year to meet the increasing demands of the service for more facilities of this kind. Initial allotments have been made, and sites are being examined for depots at Portland and Rockland, Me., and Newport, R. I.

Several projects for improving and enlarging existing depots have been completed during the fiscal year or were in active progress. At Edgemoor Depot, Del., the reconstruction of the south wharf and bulkhead was completed. At Portsmouth Lighthouse Depot, Va., the deck of the wharves, also the roads in the reservation, were covered with reinforced concrete. Considerable work has been done at the depot at San Juan, P. R., to restore the buildings, wharves, and grounds damaged by the hurricane of September 13, 1928.

At Chicago, Ill., in view of important city improvements on the water front, which required the occupation by the city of the former depot, an exchange has been effected whereby the Lighthouse Service has acquired from the city a valuable site for the depot at the east side of Ogden Slip, on the north side of Chicago River near its entrance. This exchange was authorized by an act of Congress approved May 29, 1928, and by city ordinance of October 31, 1928. The new site has been occupied by the transfer of buildings from the former depot.

A depot at Seattle, Wash., on Lake Union, has been acquired on Government property by transfer. A 150-foot extension to the wharf at the Goat Island Lighthouse Depot, San Francisco, Calif., has been completed, and a new concrete retaining wall, which will provide additional area. At Honolulu Lighthouse Depot, Hawaii, a reinforced concrete wharf and a sea wall along the bulkhead has been completed, and the construction of modern depot buildings and shops is in progress.

VESSELS OF THE LIGHTHOUSE SERVICE

REPLACEMENT OF VESSELS

The Lighthouse Service at the end of the fiscal year had in commission 110 vessels. The situation as to the replacement of obsolete and old vessels has been considerably improved.

Six lightships and two tenders are being constructed under contracts aggregating \$1,639,274, and which it is expected will result in the replacement of lightships *No. 1*, *No. 5*, *No. 13*, *No. 41*, *No. 67*, and *No. 70*, and the tenders *Water Lily* and *Poinsettia*, which vessels are beyond economical repair for this service.

Plans have been prepared for a new steel tender to replace the wooden tender *Laurel*, the hull of which is in bad condition, not worth repair; much of the machinery of the *Laurel* will be used. Plans are being prepared for a small steel tender to replace the *Birch*, which is also beyond economical repair. Preliminary plans have been made for a new steel hull to replace the wooden hull of the tender *Woodbine*.

The condition of the vessels in the service now indicate that two new tenders will be required within the next two years for replacement purposes. An additional 100-foot tender is required for the tenth district, for service in Lake Ontario.

LIGHTHOUSE TENDERS

Lighthouse tenders during the year steamed a total of 482,506 nautical miles in the various maintenance, construction, and inspection work, an average of approximately 8,616 miles for each tender. The total quantity of fuel consumed by tenders during the year was 41,561 tons of coal, 99,365 barrels of fuel oil, 31,851 gallons of gasoline, and 3,770 gallons of kerosene. The total cost of maintenance of tenders during the year was \$2,278,655, exclusive of repairs which cost \$294,834.

The tender *Manzanita* has been changed from coal to an oil burning vessel during the year. The improvement has increased the cruising distance without refueling, reduced the personnel, and has resulted in other economies of operation.

The gasoline-propelled tender *Poinsettia* was destroyed by explosion and fire on December 27, 1928.

At the end of the year there were 55 tenders in commission; 19 of these are equipped with radiocompasses, and 30 have radiotelegraph. No tenders have been put into commission, condemned, or sold during the year.

The following tenders have been extensively overhauled during the fiscal year: *Ilex*, *Lotus*, *Shrub*, *Iris*, *Mangrove*, *Palmetto*, and *Manzanita*.

The following was the number of tenders of the Lighthouse Service in commission on June 30 of the years specified, omitting those not having regular crews: 1910, 51; 1915, 45; 1920, 55; 1925, 55; 1926, 56; 1927, 57; 1928, 56; 1929, 55. On June 30, 1929, 50 tenders were in actual service, and 5 were undergoing repairs. There are 10 small depot tenders without regular crews.

LIGHTSHIPS

Lightships are maintained on 45 stations. At the end of the year 55 lightships were in commission, including 10 relief ships. They averaged 268 days on station per vessel. The total cost of maintenance of lightships during the year was \$1,126,176, exclusive of repairs, which cost \$148,394. The lightship station at Lansing Shoal, Mich., was discontinued October 6, 1928, on the completion of the new light and fog signal station.

The following lightships have been extensively overhauled during the fiscal year: Cape Charles, Va., *No. 72*; Portland, Me., *No. 74*; Relief, *No. 76* (eighteenth district); Barnegat, N. J., *No. 79*; Frying Pan Shoals, N. C., *No. 94*; and South Pass, La., *No. 102*.

The following was the total number of lightships on June 30 of the years mentioned: 1910, 68; 1915, 66; 1920, 62; 1925, 59; 1926, 56; 1927, 57; 1928, 56; 1929, 55. Lightship stations, 1910, 51; 1915, 53; 1920, 49; 1925, 46; 1926, 46; 1927, 45; 1928, 46; 1929, 45.

During the year Cape Charles, Va., and Brunswick, Ga., lightship stations were discontinued and the ships moved to new stations as follows: Cape Charles, Va., lightship was moved to Chesapeake Bay entrance and renamed *Chesapeake*; Brunswick, Ga., lightship was moved to the entrance of the St. Johns River, Fla., and renamed *St. Johns*.

Grays Reef Lightship *No. 56* was condemned, and was sold in December, 1928, being beyond economical repair.

Of the present lightships 42 have self-propelling machinery, 11 are provided with sail power only, and 2 have no means of propulsion.

Very truly yours,

GEORGE R. PUTNAM,
Commissioner of Lighthouses.

COAST AND GEODETIC SURVEY

DEPARTMENT OF COMMERCE,
COAST AND GEODETIC SURVEY,
Washington, July 1, 1929.

The honorable the SECRETARY OF COMMERCE.

DEAR MR. SECRETARY: In response to your request I furnish the following report upon the work of the bureau during the past fiscal year:

HYDROGRAPHIC AND TOPOGRAPHIC WORK

During the fiscal year 1929 hydrographic, topographic, and control surveys were made on various sections of the Atlantic and Pacific coasts, along the Alaska coast, in the Hawaiian Islands, and in the Philippines. To perform these surveys, which comprised 38 separate projects, 25 different survey units were employed.

A summary of the surveys accomplished or in progress at the close of the year is given below:

Atlantic coast.—At the beginning of the fiscal year the survey ship *Lydonia* was engaged on a resurvey of the southern part of the coast of Maine. New surveys were carried northward from Portsmouth, N. H., to Portland, Me. A wire-drag party completed the sweeping of a trial course for deep submergency tests of submarines in the vicinity of Portsmouth, N. H. A resurvey of Gloucester Harbor and the Annisquam River, Mass., was completed. Revision surveys were made at Newburyport and Hampton, Mass., and at Edgartown, Oak Bluffs, Gardiners Bay, and Jamaica Bay, N. Y. Revision of the Potomac River triangulation was completed. The survey ships *Ranger* and *Natoma* made new surveys in the entrance of the Delaware River and in the vicinity of Five-Fathom Bank. An original survey of the Cooper River from Charleston, S. C., to the Seaboard Air Line bridge was completed. On the Florida coast topographic, hydrographic, and control surveys were carried southward from the vicinity of Ponce de Leon Inlet to Cape Canaveral by the party on the survey ship *Lydonia*. The ships *Ranger* and *Natoma* completed similar surveys from Jupiter Inlet southward to Hillsboro Lighthouse, and in addition the party on the *Natoma* developed the shoals off Cape Canaveral. Control surveys for the reduction of air photographs were made along the Florida coast in connection with other operations. Examinations were made by the party on the *Ranger* of several reported shoals between Hillsboro Lighthouse and Miami, and revised the triangulation in a portion of Biscayne Bay. On the west coast of Florida surveys of San Carlos Bay and the Caloosahatchee River were completed by the party on the survey ship *Hydrographer*. This party also completed the triangulation and traverse necessary to control the air photographs between San Carlos Bay and Cape Sable. A revision survey of Mobile, Ala., water front was made.

Pacific coast.—On the Washington coast a shore party had started control and topographic surveys preparatory to taking up hydrographic work between Cape Elizabeth and Cape Flattery. Chart revision work was done in the vicinity of Seattle.

On the Oregon coast the survey ship *Pioneer* completed the project on which it had started during the latter part of the previous fiscal year, namely, a complete topographic and hydrographic survey of the coast from Cape Foulweather to Cape Arago. This work extended approximately 60 miles offshore. Inshore work was done by the launch party from Cape Blanco southward to Cape Sebastian.

On the California coast the survey ship *Discoverer* completed the project it had started during the latter part of the previous fiscal year, namely, a complete topographic and hydrographic survey of the coast from Cape Sebastian southward to Crescent City. The offshore hydrography was carried southward to Redding Rock and extended approximately 60 miles offshore. During the latter part of the fiscal year this party started on a similar project which extended southward from Cape Mendocino to Point Reyes. At the end of the year the work had been carried to the vicinity of Point Arena. A launch party engaged on inshore hydrographic and topographic surveys had completed work from Crescent City southward to Mussel Point. Near the end of the fiscal year the survey vessel *Pioneer* started on a new project which extends from Point Reyes to Point Sur. Considerable revision work was done in San Francisco and vicinity.

Alaska.—In southwest Alaska the party on the survey ship *Surveyor* completed a large offshore area southwest of Montague Island. This work extended offshore to Portlock Bank. Surveys were also made by this party in the approaches to Resurrection Bay and in Harris and Two Arm Bays. A survey made in Sitkalidak Strait, Kodiak Island, by a subparty of the *Surveyor* disclosed a passage which shortens the steamer track of vessels approaching Port Hobron from the westward by approximately 40 miles. At the end of the fiscal year the party on the *Surveyor* had taken up work on the north and west coast of Kodiak Island and was engaged on surveys in Shelikof Strait and in Uganik, Uyak, Zachar, and Alitak Bays. While working at this project the party dragged the area where the steamer *Aleutian* was wrecked and disproved the existence of an uncharted rock in that locality.

Hawaiian Islands.—At the end of the fiscal year the survey ship *Guide* had practically completed the survey of the inlets, shoals, banks, and adjacent waters which extend westward from Niihau Island to French Frigate Shoals. During the winter season this vessel surveyed a large area west and northwest of the island of Hawaii and made detailed surveys of the landings at Honokaa and Kukuihaele on the north coast of the island. A revision survey of Kahului Harbor on the north coast of Maui Island was also made by this party.

Philippines.—The survey ships *Pathfinder*, *Fathomer*, and *Marinduque* were employed throughout the year on surveys in Balintang Channel, Lyzon Strait; on the east coast of Luzon, in the vicinity of Casiguran Sound; in the Sulu Archipelago, in the vicinity of Tawi Tawi Island; and on the south coast of Mindanao, in the vicinity of Davao and Dumanquilis Bay.

Hydrography, topography, and triangulation (second and third order) performed during year

Locality	Hydrography			Topography		Triangulation (second and third order)		
	Miles of sounding lines	Area in square miles	Number of soundings	Length of shore line surveyed in miles	Area surveyed in square miles	Length of scheme in miles	Area covered in square miles	Number of geographic positions determined
Coast of Maine	2,616	461	33,344			32	317	10
Isles of Shoals, Me.	WD 45	WD 26						
Gloucester Harbor, Mass.	190	3	12,092	6	24	7	12	31
Newburyport, Marthas Vineyard and Gardiners Bay, Mass., and N. Y.	492	31	23,874	38	6	65	168	31
Jamaica Bay, N. Y.	229	13	6,663	74	15			
Cape May, N. J.	1,934	126	40,701	10	30	19	20	3
Delaware Bay	1,225	69	25,511					
Potomac River, Md. and Va.						46	108	100
Cape Lookout, N. C.	188	11	1,618	7				
Cooper River, S. C.	390	7	16,178	90	12	26	21	59
Cape Canaveral, Fla.	3,989	2,624	52,036	65		27	151	32
West Palm Beach and Cape Canaveral, Fla.	1,262	144	18,197			39	6	25
Lake Worth to Hillsboro, Fla.	1,398	216	29,463	38	10	45	60	28
Cape Sable to San Carlos Bay	1,156	41	38,987	11	3	40	150	74
West coast Florida (air photo reduction)				150	773			
La Jolla, Calif.	114	7	2,261	9	5			
San Francisco Bay, Calif.	15	1	1,506	44	21	20	20	9
Point Reyes, Calif.	202	26	3,226	7	3	35	86	39
Shelter Cove to Point Arena, Calif.	2,807	4,133	16,684	74	21	14	18	18
Crescent City to Mussel Point, Calif.	307	42	6,200	52	72			
Cape Sebastian to Trinidad Head, Calif. and Oreg.	6,837	5,600	54,074	114	83			
Coquille River to Cape Sebastian, Oreg.	598	94	9,738	58	65			
Cape Foulweather to Cape Arago, Oreg.	6,978	4,665	42,743	74	31			
Behm Canal, Alaska						78	136	68
Keku Strait and Wrangell Narrows, Alaska	738	17	51,691	48	17	30	28	87
Taku Inlet, Alaska						26	75	17
Kruzoff Island and Peril Strait, Alaska	860	124	9,986	110	130	68	615	21
Southwest Alaska	WD 32	WD 18	WD 11					
Hawaiian Islands	5,857	3,552	42,196	239	212	88	434	157
North of Luzon and Mindanao, P. I.	15,755	33,795	85,340	36	4		260	44
East coast Luzon and Mindanao, P. I.	6,026	7,655	34,099	108	135	69	1,405	15
Sulu and Mindanao, P. I.	5,411	3,233	44,713	104	115	77	1,000	6
	6,830	493	143,385	160	75	27	75	17
Total	74,481	67,227	846,517	1,726	1,862	878	5,165	891

GEODETIC WORK

	Length of scheme	Area covered		Length of scheme	Area covered
	Miles	Sq. mi.		Miles	Sq. mi.
Triangulation, first-order:			Reconnaissance, first-order triangulation—Continued		
Maine, Augusta to international boundary	80	2,700	Missouri, Kentucky, Arkansas, and Tennessee, Cairo to Memphis	145	1,600
Pennsylvania and Ohio, Pittsburgh arc	85	1,100	Arkansas, Mississippi, and Louisiana, Memphis to Natchez	270	1,700
Ohio, Columbus arc	225	2,500	Mississippi and Louisiana, Natchez to New Orleans	180	1,300
Kentucky, Owingsville to Virginia-Tennessee boundary	120	2,850	California, Newport Beach to Lucerne Valley	90	1,600
Kentucky, Bardstown to Berea	65	1,000	Total	2,155	22,800
Kentucky, Owingsville to Portsmouth, Ohio	50	600	Leveling, first-order:		
Iowa, Missouri, and Arkansas, ninety-third meridian arc	420	5,400	Montrose, Colo., to Farmington, N. Mex.	148	
Missouri, Springfield to Van Buren	95	1,600	Farmington to Shiprock, N. Mex.	30	
California, Newport Beach to Bear Lake	60	1,100	Alexandria, Va.	3	
Total	1,200	18,850	Tucumcari to Taylor Springs, N. Mex.	103	
Triangulation, second-order: California, Redding to Humboldt Bay	85	2,400	Greenup to Jackson, Ky.	128	
Base line, first-order: Ohio, Burg-hill	5.8		Somerset to Glasgow Junction, Ky.	102	
Reconnaissance, first-order triangulation:			Monett, Mo., to Memphis, Tenn. (part of line), 362-40-322	322	
New York and Pennsylvania, Buffalo, N. Y., to Canton, Pa.	150	1,200	Covington to Richmond, Va.	257	
Kentucky, Berea to Portsmouth, Ohio	110	1,600	Baleony Falls to Harpers Ferry, W. Va.	185	
Arkansas, Danville to Missouri boundary	120	1,800	Washington, D. C.	1	
Missouri, Springfield to Charleston	190	2,700	Taylor Springs, N. Mex., to Pueblo, Colo. (part of line)	14	
Arkansas, Louisiana, and Texas, ninety-fourth meridian arc	310	3,000	Total	1,290.3	
Louisiana, Mississippi, and Alabama, Shreveport to union base	390	4,100	Summary:		
Georgia and Alabama, Atlanta to Montgomery	200	2,200	First-order triangulation	1,200	18,850
			Second-order triangulation	85	2,400
			First-order base line	5.8	
			First-order triangulation, reconnaissance	2,155	22,800
			First-order leveling	1,290.3	

For several years the funds available for geodetic work have been devoted largely to the extension of the first-order triangulation net of the country. This has been done with a view to supplying those missing arcs that are needed in the adjustment of the net in order that final or standard geographic positions can be furnished those desiring the data. The time comes in the conduct of the geodetic work of a nation when the network of arcs of triangulation must be adjusted in a single unit and those unavoidable discrepancies where two arcs join must be distributed over the net according to the best mathematical methods. This has already been accomplished for the western half of this country. The eastern border of that net is an arc of triangulation which extends from Canada to Mexico, approximately along the ninety-eighth meridian. During the fiscal years 1930 and 1931, even if no increase in appropriations for the geodetic work is made, additional arcs for the eastern half of the country will be executed.

Triangulation during the past fiscal year has been extended from central Iowa along approximately the ninety-third meridian south to central Arkansas, with a spur line from that arc running eastward for 100 miles from Springfield, Mo. That arc of triangulation which extends from the vicinity of Martinsburg, W. Va., northward via Pittsburgh, Pa., to the Lake Survey triangulation in northeastern Ohio was completed. Part of that arc was executed in the previous fiscal year. An arc of triangulation was begun in the vicinity of Sandusky, Ohio, and carried southward to a point about 60 miles north of Portsmouth, Ohio, during the first half of the fiscal year. Late in the fiscal year this work was resumed and it is expected that it will be completed very early in July, 1929. An arc of triangulation was begun in the summer of 1928 in Maine and was completed in June, 1929. The work had to be discontinued in the fall of 1928 because of unfavorable atmospheric conditions.

An arc of triangulation for the study of earth movements in California was begun during the early part of the fiscal year in southern California. This arc will run between Newport Beach and Lucerne Valley. About three-fourths of that arc were completed during the fiscal year. The remainder will be executed in the early part of the fiscal year 1930. The location of the arc was decided on by officials of this bureau in consultation with members of the committee on seismology of the Carnegie Institution of Washington. By executing arcs of triangulation over regions subject to earthquakes in the past, and the location of many triangulation stations which are well monumented, one is able by making new observations in the future to determine whether the ground has undergone strain in horizontal direction and its extent. If an earthquake should occur in this region, the reobservation of the angles of triangles would enable one to determine the amount of movement at different places and to determine the distance from the actual fault resulting from the earthquake that movement has occurred. This work, which is considered to be of prime importance for the study of earthquakes, is in its infancy, and it is believed that exact knowledge of the behavior of an earthquake may have a large influence on the practical affairs of our people.

First-order levels were run between Republic, in western Missouri, along the St. Louis-San Francisco Railway to Memphis, Tenn. A line was run from Montrose, Colo., to Farmington, N. Mex., and another from Tucumcari to Taylor Springs, N. Mex. Two lines of first-order leveling aggregating 230 miles were run in Kentucky. In Virginia levels were run from Covington to Richmond along the Chesapeake & Ohio Railroad and from Glasgow Junction to Harpers Ferry along the Norfolk & Western, Baltimore & Ohio, and the Southern Railways. The latter work was executed at the request of the United States Geological Survey which furnished the funds for the field expenses.

A party of the Coast and Geodetic Survey was engaged during the first five months of the fiscal year in determining astronomic longitudes and latitudes and occasionally azimuths at triangulation stations in Iowa, Minnesota, Wisconsin, and Illinois. The astronomic data secured are essential to the adjustment of the triangulation of the eastern half of the country.

The variation of latitude station at Ukiah, Calif., has been kept in operation during the fiscal year and the record of observations furnished to Prof. H. Kimura, president of the International Commission on the Variation of Latitude. The Ukiah work was done in cooperation with the Governments of Japan and Italy and with officials of the International Astronomical Union and the International Geodetic and Geophysical Union.

MAGNETIC AND SEISMOLOGICAL WORK

Magnetic stations occupied during the fiscal year ended June 30, 1929

Alabama.....	2	Ohio.....	8
Alaska.....	14	Pennsylvania.....	3
Florida.....	5	South Carolina.....	5
Georgia.....	14	South Dakota.....	1
Indiana.....	2	Tennessee.....	3
Kansas.....	3	Texas.....	8
Kentucky.....	4	Virginia.....	10
Louisiana.....	2	West Virginia.....	3
Mississippi.....	3		
Nebraska.....	5	Total.....	96
North Carolina.....	1		

As shown in the table the principal magnetic work has been in the section of the country lying eastward of a line from southern Texas to western Pennsylvania, an area in the northwest, and in the interior of Alaska. In the latter survey observations were made at points never hitherto reached for this purpose.

Continuous recording of the magnetic elements was in progress at five magnetic observatories. The hurricane destroyed several buildings at San Juan, P. R., but fortunately not those containing the essential magnetic instruments, and these have been kept in operation. New methods which facilitate observations have been put in effect at a number of observatories. Cooperative magnetic observations were carried on at Duke University, Durham, N. C. Special auroral observations were made at Sitka.

Seismology.—Instrumental observations have been made at Tucson, Sitka, at the cooperative stations at the University of Hawaii and the University of Chicago, and at the San Juan Observatory up to the time of the hurricane. No observations have been made in Porto Rico since that time. Several new seismographs have been tested at Cheltenham, which is used primarily for this purpose.

The collection of reports on the visible and felt effects of earthquakes as made by volunteer observers is becoming better organized. The inspector in charge of the field station at San Francisco has done important work in organizing the collection of reports in the Pacific coast region.

TIDE AND CURRENT WORK

In addition to numerous short series of tide observations along the coasts of the United States and possessions in connection with hydrographic surveys, tide observations were continued at primary tide stations of the bureau for the purposes of furnishing general tidal control for hydrographic surveys in the various regions represented and for the determination of tidal datum planes.

Primary tide stations

Portland, Me.
 Portsmouth, N. H. (cooperative).
 Boston, Mass.
 Fort Hamilton, N. Y.
 New York, N. Y.
 Atlantic City, N. J.
 Philadelphia, Pa.
 Annapolis, Md. (cooperative).
 Baltimore, Md.
 Hampton Roads, Va. (cooperative).
 Charleston, S. C.
 Mayport, Fla. (cooperative).
 Daytona Beach, Fla.
 Key West, Fla.

Pensacola, Fla.
 Galveston, Tex.
 San Diego, Calif. (cooperative).
 La Jolla, Calif.
 Los Angeles, Calif. (cooperative).
 San Francisco, Calif.
 Astoria, Oreg.
 Seattle, Wash.
 Valdez, Alaska.
 Ketchikan, Alaska.
 Seward, Alaska.
 Honolulu, Hawaii (cooperative).
 Hilo, Hawaii (cooperative).

Within the past few years considerable saving has been made in the appropriation for tides and currents in establishing primary tide stations in cooperation with other organizations having personnel in the immediate localities in which the tide observations are desired. Of the 27 primary tide stations 8 are cooperative, or more than 25 per cent of all. These cooperative tide stations are maintained and operated at practically no additional cost to the Government, and the records are forwarded to this bureau for our permanent files.

Tide observations, secondary stations.—In addition to the primary tide stations, short series of tides are observed by hydrographic parties either with standard or with portable tide gages. Tides were observed at 67 stations, with a total of 17 years and 7.9 months.

Staff observations.—In addition to the primary and secondary stations, tides were observed on plain tide staffs, for hydrographic purposes, and were recorded in books. Tides were observed on plain staff gages at 41 stations, with a total of 4 years and 0.3 months.

Tide observations, outside sources.—Tide records were received from sources outside this bureau from 28 tide stations, totaling 17 years and 9.2 months of records. These records are in addition to the cooperative primary tide stations.

Summary of tide records received

	Stations	Years	Months
Eastern coast.....	60	18	5.9
Gulf of Mexico coast.....	10	4	4.3
Pacific coast.....	29	10	5.8
Alaskan coast.....	15	3	10.5
Outlying territory.....	18	54	11.9
Total.....	152	92	2.4

Current observations.—Short series of currents were observed as listed below:

Summary of current observations

	Stations	Year	Months
Short series.....	186	1	9.8

In continuing the program of tide and current surveys of important harbors, Chesapeake Bay and tributaries were completed during the fiscal year. Because of the wide extent of the waterways comprising this system two field seasons were necessary, the upper part of the bay being surveyed in the fiscal year 1928 and the lower in 1929. During the past fiscal year 106 current stations and 23 tide stations were observed during this survey. The results have been tabulated and reduced and the manuscript for a publication on tides and currents in Chesapeake Bay and tributaries is nearing completion and will be sent to the printer early in the present fiscal year. In the last month of the fiscal year 1929 a tide and current survey of Long Island Sound and tributaries was begun. This will be completed during the fiscal year 1930.

At Fort Hamilton, N. Y., the tide station which had been in operation for about a year and a half was discontinued on December 31, 1928, the series derived furnishing the observation required.

The tide station at Valdez, Alaska, which was in operation for several years, was discontinued October 4, 1928, the observations obtained being sufficient for the purpose for which this station was established.

A portable automatic tide gage has been loaned to the Florida Railroad & Navigation Corporation for the purpose of securing a series of tidal observations on the west coast of Florida, the records to become the property of the Coast and Geodetic Survey. This gage is operated at no cost to the survey.

Through a cooperative arrangement between this survey and the Chamber of Commerce of Cordova, Alaska, a series of tide observations is being obtained at that place.

At the request of the city of Fort Lauderdale, Fla., a portable automatic tide gage has been established at that place to be operated for a period of about a year.

In order to furnish data in connection with a lawsuit to which the Government is a party, two portable automatic tide gages were maintained during the month of February in the vicinity of Benning's Bridge, D. C., in cooperation with the United States Army Engineers. Members of the division were called upon to testify in court as expert witnesses in connection with this case.

In addition to the tide records, temperature and density observations—frequently requested by operators of cold-storage plants, by fishing concerns, and by investigators of the ravages of pile-boring *limnoria*—were made at all primary tide stations at no increase of cost to the Government. Short series of these observations were also made at all current stations occupied in the current survey of Chesapeake Bay and tributaries.

The following cooperation was given the Coast and Geodetic Survey in tidal work during the year:

The primary tide station at Annapolis, Md., which is operated cooperatively by this bureau and the Naval Academy was put into operation on August 7, 1928. Aside from serving as a primary tide station, it is also to be used for the purpose of instructing the midshipmen in tidal work.

The Navy cooperated in the operation of tide stations at the Portsmouth (N. H.) Navy Yard, San Diego, Calif., and at the naval operating base, Hampton Roads, Va.

The chief hydrographer, Canal Zone, furnished tide observations for the full year at two tide stations in the Canal Zone.

The city of Los Angeles and the Territory of Hawaii are cooperating in the maintenance and operation of tide stations at Los Angeles, Hilo, and Honolulu, respectively.

Capt. G. St. Maur Stocker, Swatow, China, is furnishing the records from a series of tide observations being obtained at the entrance to Swatow Harbor.

During the fiscal year the following primary tide stations were visited and levels run between tide staffs and bench marks:

Portland, Me.
 Portsmouth, N. H.
 New York, N. Y.
 Baltimore, Md.
 Annapolis, Md.
 Charleston, S. C.
 Mayport, Fla.
 Jacksonville, Fla.
 Daytona Beach, Fla.

Key West, Fla.
 Everglades, Fla.
 Astoria, Ore.
 Seattle, Wash.
 Ketchikan, Alaska.
 Cordova, Alaska.
 Valdez, Alaska.
 Seward, Alaska.
 Honolulu, Hawaii.

The accomplishments of the Washington office of the bureau during the fiscal year, by divisions and sections, follow.

CHIEF CLERK

The principal duties of this division are the care, custody, and upkeep of the building occupied by the bureau; the supervision of the expenditures for office expenses, including the purchase of supplies for the office and to some extent for the field; the care of most of the original records of the field surveys, as well as the library of printed publications; the general supervision of all matters relating to the personnel work, including reports of leaves of absence; the custody and accounting for the receipts from the sale of charts, publication, etc.; and the direction of the employees engaged in the care, maintenance and protection of the buildings occupied by the bureau in the District of Columbia.

In the library and archives 109 hydrographic and 87 topographic sheets, each representing new surveys made by the bureau, were received. Other additions were blue prints (mostly showing surveys made by Army Engineers), 616; maps, 3,253; charts, 2,346; field, office, and observatory records, 3,913; photographs and negatives, 171; prints, 400; lantern slides, 156; books, 467.

The total number of permanent and temporary employees in the office and field forces, which includes commissioned officers and all employees appointed through civil-service certification, is: Office force, 221; field force, 199; total, 420. These figures do not include the persons engaged as rodmen, chainmen, heliotroppers, and others in the field parties nor any enlisted men on vessels.

The statistics in regard to leave of absence during the calendar year are: Annual leave, 7,459 days; sick leave, 1,829 days; without-pay leave, 285 days; accrued leave, 3,264 days. While the number of employees naturally varied on account of resignations and vacancies, calculated on the number actually in the service on June 30, 1929, as a basis of computation, the average annual leave taken during the year by each employee was approximately 17.37 days and sick leave 4.35 days.

The receipts from the sale of charts and nautical publications prepared by the bureau amounted to \$65,545.42. The funds realized from the sale of old property, work done, and miscellaneous sources amounted to \$4,707.63.

DIVISION OF HYDROGRAPHY AND TOPOGRAPHY

The work performed by the administrative and other officers of this division stationed at the Washington office is quite diversified. It consists of the preparation of plans and instructions for field surveys, the supervision of field work, and the examination of the records of field parties. These officers prepare plans and specifications for new vessels and for hydrographic surveying equipment. They also supervise repairs and upkeep of the vessels. Research work is carried on in connection with new surveying methods and appliances.

During the past year experiments were made on a new type of echo-sounding apparatus for use in shallow water and a new instrument was devised for getting more accurate measurement of deep water by means of echo sounding. A course of instruction was carried out in the division for the education of field officers in the use of echo-sounding apparatus and sound ranging. All field officers stationed in Washington took this course of instruction.

The preparation of manuscript for coast pilots and inside route pilots was performed by the coast pilot section of the division from information obtained by an officer of the division who made a thorough field inspection of the area covered by the coast pilot. This section compiled during the year a publication containing tables for ascertaining navigable distances between the ports of the United States ports to a number of foreign ports. This publication lists over 400 ports and points on inland waterways and is intended to supplement the series of coast pilots by providing a convenient means for ascertaining navigable distances between the ports of the United States and its offlying territories.

DIVISION OF GEODESY

The following important pieces of work were completed during the year or were in progress at the end of the fiscal year:

Computation and adjustment of the following pieces of triangulation.—

1. Readjustment of the first-order triangulation west of the ninety-eighth meridian. Main scheme and intersection points completed.
2. Southeast Alaska: Main scheme completed and partly prepared for publication.
3. Territory of Hawaii: Adjustment completed and manuscript of publication sent to the printer.
4. Readjustment of the first-order triangulation net east of the ninety-eighth meridian. Preliminary work only.

Computation of leveling.—About 1,300 miles of leveling located in New Mexico, Kentucky, Tennessee, Virginia, West Virginia, and Colorado.

Computation of the following astronomic and gravity work.—

1. Azimuths: 37 stations in the United States, Alaska, and Hawaiian Islands.
2. Longitudes: 19 stations in the United States. Work was also done in preparing for publication the world longitude determinations made by this bureau in 1926.
3. Longitudes: 11 stations in the United States.
4. Laplace azimuths: Computation of true geodetic azimuths at 19 Laplace stations.
5. Isostatic reductions: Computation of the reduction for topography and isostatic compensation at 49 sea stations determined in fall of 1928 by cooperation of the United States Navy, Carnegie Institution of Washington, and Dr. F. A. Vening Meinesz. Also same computations for 3 stations in Hawaiian Islands.

6. Gravity computations: Computation of 3 stations in Hawaiian Islands and of various standardizations and experimental work at Washington, D. C.

Investigations were carried on during the year in the following subjects: Interior of the earth, lunar theory, variation of latitude, California earthquakes, and tidal friction.

The following publications were issued by the division during the fiscal year:

- Special Publication 140, Manual of First-Order Levelling.
 Special Publication 145, Manual of Second and Third Order Triangulation and Traverse.

Special Publication 151, Comparison of Old and New Triangulation in California.

Special Publication 153, Conformal Projection of the Sphere Within a Square.

Special Publication 156, Triangulation in the Hawaiian Islands (in press).

Special Publication 77, Precise Leveling in Texas (revised edition).

Serial 257, Geodetic Surveys—Methods, Instruments, and Purposes (revised edition).

DIVISION OF CHARTS

The printing and distribution of charts increased by more than 7,000 copies during the year. This is approximately the normal annual increase that has been continuing for the past 15 years. The sale of tide tables and current tables is the largest we have ever had. These are substantial evidences of growth. There are many indications that during the coming year this volume will be exceeded.

There is a persistent demand from various sources for charts of localities not previously published. Charts of several rivers and comparatively shoal areas heretofore considered unimportant for navigation but now coming into importance on account of the phenomenal increase in the number of motor boats are on our program. The addition of a new chart to the number on issue requires not only the work of compilation and preparation of plates but also continuous correction, year after year, work which is already taxing the capacity of the division. This demand for charts of new areas must be met to the best of our ability and between 1925 and 1929, 31 new charts have been added to the list on issue.

Photographic copies of original survey sheets are quite extensively used in the study of important engineering projects as base maps for local improvements and assessments and as evidence in litigation involving valuable property rights. These records are highly valuable, judging by the number of complimentary letters received.

The progress in airway mapping has fallen behind the increasing demand for airway charts. The production of strip maps is being curtailed to permit undertaking general flying maps which will eliminate considerable duplication caused by overlapping strips.

Accomplishments for the year.—There were 13 new nautical charts produced and 10 new editions of existing charts; 3 airway strip maps published, 5 reprinted, and 5 nearing completion. All existing charts were kept up to date and weekly Notices to Mariners prepared for publication.

Below is given a 5-year comparative statement showing the total number of nautical charts on issue, the new charts constructed, and new editions issued during the year; also the cancellations of obsolete charts. On account of very extensive corrections several of the 84 new editions listed for 1929 required practically as much work as a new chart.

	1925	1926	1927	1928	1929
Current charts on issue.....	679	687	691	702	710
New charts.....	13	10	16	18	13
New editions.....	114	97	94	74	84
Charts canceled.....	8	2	12	7	5

The charting program for 1930 includes 13 new nautical charts, 5 charts to be reconstructed, 9 new airway strip maps, 2 sectional charts of a series that will eventually cover the entire country. The work of first importance will be keeping existing charts up to date.

DIVISION OF TERRESTRIAL MAGNETISM AND SEISMOLOGY

The principal accomplishments have been:

1. The resumption of preparation of magnetic observatory results for publication. Progress has been made though the amount is unsatisfactory. Further improvements in methods have been made.

2. Preparation of the field results for publication. This has been kept practically up to date.

3. Preparation of the magnetic tables and charts for 1925 was completed. This publication should meet the need for which it is prepared for many years.

4. Progress has been made in the preparation of magnetic information by groups of States. A volume covering the area from Delaware to Tennessee was practically completed and the necessary maps compiled.

5. A program of development of instruments and methods with study of the underlying theory has been an important activity. There have been improvements in the standard methods and new materials and apparatus have been adopted for solving the problems as they have become available.

6. Attention has been given to some of the major problems relating to the earth's magnetism, and a special effort has been made to keep in touch with all the various organizations throughout the earth which are now very actively attacking this problem. Special mention should be made of cooperation with the Navy Department and the Carnegie Institution of Washington.

SEISMOLOGY

Only a partially successful effort has been made to put the available information into finished form. The delay in the issue of our quarterly seismological report has become quite serious but in so far as other observatories are concerned their needs have been met by advance information from our observatories. Immediate determination of position of earthquakes through reports from cooperative organizations and observatories has proved so valuable that upon request from Great Britain the service has included transmission of earthquake information to Europe as part of the meteorological messages of the Weather Bureau. Advice and information has been furnished to those contemplating the installation of instruments and other various activities related to the earthquake problem.

DIVISION OF TIDES AND CURRENTS

Owing to the increased calls for tide and current data and because of the additional data obtained from the current and tide surveys the work in the office of the division of tides and currents has increased considerably in the past few years, without a commensurate increase in the personnel.

Upon the completion of a tide and current survey, one of which is made in a different harbor each summer, the observations are reduced and the manuscripts for special publications on the tides and currents in these harbors are prepared for printing in the next fiscal year. The survey of Chesapeake Bay and tributaries was completed early in the past year and manuscript is now being prepared for publication.

These comprehensive tide and current surveys were begun in 1922, and to the present time the following special publications, dealing with tides and currents in the respective harbors, have been issued:

Currents and tides in harbors

No. 111. New York Harbor, 1925.	No. 127. Southeast Alaska, 1927.
No. 115. San Francisco Harbor, 1925.	No. 142. Boston Harbor, 1928.
No. 123. Delaware Bay, 1926.	No. 150. Portsmouth Harbor, 1929.

Special Publication 148, Tidal Bench Marks, State of New Jersey, received from the printer during the fiscal year, is part of a series containing descriptions and elevations of tidal bench marks along the coasts of the United States. The following are publications of this series issued to the present time:

Tidal bench mark publication

No. 83. New York, 1922.	No. 141. California, 1928.
No. 119. District of Columbia, 1925.	No. 148. New Jersey, 1929.
No. 128. Rhode Island, 1926.	No. 155. Massachusetts (in press).
No. 136. Connecticut, 1927.	

Special Publication 154, Instructions, Primary Tide Stations, which was prepared as a supplement to Special Publication 139, was sent to the printer in January, 1929. This publication contains instructions pertaining to the operation of a primary tide station and the preliminary reduction of the records.

Two new publications that were issued during the fiscal year, Tide Table, Boston Harbor and Vicinity, and Tidal Current Charts, New York Harbor, have been well received by the public, the unexpected demand for the current charts necessitating a reprint within a few months of the original issue. This publication gives by means of a set of 12 charts the direction and velocity of the current at various localities throughout New York Harbor. In addition to this information, the complete set of charts presents a comprehensive view of the tidal-current movement for the harbor as a whole. At the present time we have insistent demands for similar publications for San Francisco Bay, Boston Harbor, and Chesapeake Bay, where current surveys have already been made and observational data are available.

The predictions of tides and currents are made and the manuscript submitted to the printer each year in time to have all the tables for any calendar year ready for issue by July 1 of the preceding calendar year. Predictions of currents for the current tables for the calendar year 1931 were begun October 30, 1928, and completed November 30, 1928. Tide predictions for the tide tables for the calendar year 1931 were begun November 30, 1928, and completed January 22, 1929.

The following table, showing the issue of the tide tables for each fiscal year for the 10-year period 1920-1929, is indicative of the demand for the tables:

Fiscal year	United States and Foreign Ports Tide Tables	Atlantic Coast Tide Tables	Pacific Coast Tide Tables	New York Harbor Tide Table	Boston Harbor Tide Tables	Total
1920.....	3,469	5,357	16,061	-----	-----	24,887
1921.....	3,577	5,678	14,957	-----	-----	24,212
1922.....	3,067	5,704	14,902	-----	-----	23,673
1923.....	2,479	5,440	15,054	-----	-----	22,973
1924.....	2,509	7,097	15,234	-----	-----	24,840
1925.....	2,218	6,727	15,849	-----	-----	24,794
1926.....	2,730	6,707	15,347	-----	-----	24,784
1927.....	2,692	6,934	15,911	-----	-----	25,537
1928.....	2,377	7,281	17,009	1,962	-----	28,619
1929.....	3,257	7,276	16,896	952	1,461	29,486

The following table shows the number of copies of the current tables issued for the fiscal years 1923 to 1929, separate current tables having been issued in 1923 for the first time:

Fiscal year	Atlantic Coast Current Tables	Pacific Coast Current Tables	Total	Fiscal year	Atlantic Coast Current Tables	Pacific Coast Current Tables	Total
1923.....	2,029	1,786	3,815	1927.....	3,722	2,311	6,033
1924.....	3,124	2,002	5,126	1928.....	3,614	2,501	6,115
1925.....	2,452	2,474	4,926	1929.....	3,492	4,040	7,532
1926.....	3,014	1,763	4,777				

The United States and Foreign Ports Tide Tables for 1929 contain daily predictions for 88 reference stations and tidal differences and constants for 3,775 subordinate stations. One additional reference station, Aberdeen, Grays Harbor, Wash., was included in the 1930 edition.

In accordance with a cooperative arrangement for the exchange of tidal predictions, daily predictions for the annual tide tables are now exchanged between the Coast and Geodetic Survey and the following organizations: British Admiralty, 19 stations; Canadian Hydrographic Office, 4 stations; Deutsche Seewarte, Germany, 6 stations; and Service Hydrographique, France, 4 stations.

The production of tide and current tables has been systematized and a high degree of efficiency attained. Only nominal improvements can now be hoped for along these lines, as the present conditions are such that any further speeding up must result in loss of accuracy.

DIVISION OF ACCOUNTS

For the fiscal year 1929 the regular appropriations for the Coast and Geodetic Survey amounted to \$2,445,127. This amount was further increased to \$2,527,627 by deficiency acts, transfers from other departments, etc. The actual disbursements during the fiscal year amounted to \$2,587,862.02. This amount does not represent the actual expenses of the bureau for the fiscal year 1929, as included therein are disbursement on account of previous fiscal years.

During the year from 30 to 50 chiefs of party have disbursed funds in the field, operating throughout the entire United States and its possessions. These chiefs of party are financed by advances made to them through this division, and their accounts are in turn rendered to this division for credit to their account of advances. They are then included in the accounts of the disbursing agent, and are transmitted to the General Accounting Office for final settlement.

The primary object for these chiefs of party being in the field is the accomplishment of surveying work, and it is, and has been, the continued endeavor of this division to simplify the accounting work in every possible manner in order that a maximum of effort may be devoted by these chiefs of party to their surveying work. The majority of these officers have no permanent station, their work being migratory. The accounting work is necessarily accomplished at night after completing the day's work in the field, and under the most difficult conditions, as, for instance, by lamplight in a small tent with only the crudest facilities.

INSTRUMENT DIVISION

The development, procurement, modification, and servicing of the surveying instruments used by the field parties and observatories of this bureau in its work of geodetic, hydrographic, magnetic, tidal surveys, and other activities is the function of the bureau's instrument division. This division also records all material transfers to, from, and between field parties and the Washington office, and accounts for material at the bureau's headquarters. It is also the function of this division to design such special instruments and equipment as may be needed, to prepare drawings and specifications, and to construct sample instruments. It is also frequently necessary for this organization to design and build special machines to perform some of the highly accurate and special work which is occasioned by the construction of the various precision instruments which the bureau uses.

These various functions were carried on during the past year, and a number of new instruments and improvements were made, the more important being:

Precise level rod.—We have steadily improved the level rod both in its construction and in the method of dividing it. We have been able to develop a rod which will be of longer life, and so stable that there will not be appreciable changes in length due to usage. By the designing and constructing in our own shop of a special dividing machine we have been able to graduate these rods with a much higher degree of accuracy, and calibration is now carried one decimal place farther than was formerly possible. By means of this machine all rods are practically alike and we are experimenting, with, I understand, very favorable results, with a change in the method of conducting the leveling work whereby it is not necessary to reverse the positions of the forward and rear rods with each set-up, and the preliminary tests show a speeding up of from 10 to 15 per cent.

Second-order theodolite.—This instrument, whose design was referred to in last year's report, has been under construction during

the year and is virtually completed. A notable improvement in its design has been made in the introduction of ball bearings into the micrometer microscopes, which renders them extremely sensitive and makes them adjustable and practically free from the effects of wear. An important element of such microscopes is the reversibility of the micrometer screw. The introduction of ball bearings renders the operating parts so lacking in friction that movement is virtually instantaneous in either direction on rotation of the screw. This will result in speedier and more accurate observation.

Engine-driven sounding machine.—A new portable, air-cooled, gasoline engine-driven sounding machine has been developed for launch work and is now under field test. This machine is quite light, very powerful, and its entire control is in one hand of the operator. This machine will enable shallow soundings to be conducted with much greater ease and rapidity than where the hand sounding machine is used.

Registering sheave.—The registering sheave used by this bureau in deep-sea sounding was redesigned to incorporate a more rugged and more easily read and operated registering device, and a number of these instruments were placed in the field for testing purposes.

A new type of automatic time switch for the control of signal lamps, to eliminate the constant need of an attendant, was designed and built during the year. This switch makes use of a drop of mercury sealed into a glass tube properly mounted on suitable metal parts, connected with a clock. This type of switch will not be affected by moisture, temperature, or dirt, nor is there any tendency for the tarnishing of contacts, as in the case of some of the switches previously used. A quantity of these switches is being used during the present season.

Efforts are continually being made to improve the quality and accuracy of the instruments, and to reduce their cost by the use of improved materials and methods of construction. Every effort is made to reduce the operating expense of the shops by the introduction of labor-saving machinery, and by adding suitable apparatus for testing incoming instruments and materials.

Very truly yours,

R. S. PATTON, *Director.*

BUREAU OF NAVIGATION

DEPARTMENT OF COMMERCE,
BUREAU OF NAVIGATION,
Washington, July 1, 1929.

The honorable the SECRETARY OF COMMERCE.

DEAR MR. SECRETARY: In response to your request I submit the following report upon the work of the bureau during the past fiscal year:

AMERICAN SHIPPING ON JUNE 30, 1929

On June 30, 1929, the merchant marine of the United States, including all kinds of documented craft, comprised 25,326 vessels of 16,477,859 gross tons, of which 2,256 seagoing vessels of 10,724,030 gross tons were of 1,000 tons or over, compared with 2,336 vessels of 10,882,793 gross tons on June 30, 1928. Following is an analysis of the ownership of seagoing tonnage compared with one year ago:

Ownership and date	Steel		Wood		Total	
	Number	Gross tons	Number	Gross tons	Number	Gross tons
Private ownership (500 gross tons and over):						
July 1, 1928.....	1,361	6,351,377	573	702,920	1,934	7,054,297
July 1, 1929.....	1,433	7,018,726	520	643,770	1,953	7,662,496
U. S. Shipping Board (1,000 gross tons and over):						
July 1, 1928.....	761	4,110,061	-----	-----	761	4,110,061
July 1, 1929.....	628	3,315,692	-----	-----	628	3,315,692
Total, 1928.....	2,122	10,461,438	573	702,920	2,695	11,164,358
Total, 1929.....	2,061	10,334,418	520	643,770	2,581	10,978,188

Of these totals 1,230 vessels of 6,571,345 gross tons were engaged in the foreign trade and 1,350 vessels of 4,406,843 gross tons in the coasting trade.

Since June 1, 1921, when our foreign trade reached its greatest volume, 10,699,596 gross tons, there has been a steady decline, until June 1, 1929, it amounted to only 6,565,419 gross tons, a falling off of 4,134,077 gross tons. The decrease in the foreign trade is due principally to the scrapping of large vessels which belonged to the Shipping Board and to changes from foreign to coasting trade because of greater opportunities in that service.

Since June 1, 1921, the coasting trade, exclusive of the trade on the Great Lakes, has increased 1,962,397 gross tons. During the same nine years the total seagoing tonnage has decreased 2,165,854 gross tons.

During the year 808 vessels of 128,976 gross tons were built and documented, and on July 1, 1929, there were building or under contract to build in our shipyards 218 vessels of 169,862 gross tons. The corresponding figures for 1928 were 969 vessels of 257,180 gross tons built and 483 vessels of 264,410 gross tons under contract to build.

The new tonnage includes 5 steel passenger steamers of 29,811 gross tons, 3 steel cargo motor ships of 4,357 gross tons, 2 steel motor ship tankers of 11,877 gross tons, and 1 steel steam ferry of 2,029 gross tons, aggregating 48,074 gross tons.

On June 30, 1929, the laid-up seagoing tonnage of the United States aggregated 569 vessels of 2,232,449 gross tons, as against 760 vessels of 3,145,113 gross tons on June 30, 1928.

Details of the world's laid-up tonnage, classification of American vessels by size, service, and power, and of vessels launched and under construction may be found in Merchant Marine Statistics for 1929, a publication prepared by this office.

NAVIGATION LAWS

INSPECTION OF MOTOR SHIPS

For several years this bureau has called attention to the need of clarification and extension of the steamboat inspection laws to cover the increasing number of large vessels propelled by internal-combustion engines.

We have in the United States 11,651 documented motor vessels of over 732,000 gross tons of which 110 vessels aggregating 401,942 gross tons are each 1,000 tons or more.

The increased use in our foreign trade of motor vessels emphasizes the necessity for additional legislation covering their construction, manning, and equipment.

LOAD LINE

An act to establish load lines for American vessels was approved March 2, 1929 (Public, No. 934, 70th Cong.). It applies to all merchant vessels of 250 gross tons or over loading at or proceeding on a foreign voyage by sea from any port or place within the United States or its possessions, the Great Lakes excepted, and to merchant vessels of the United States of like tonnage loading at or proceeding for a voyage by sea from any foreign port or place, the Great Lakes excepted.

These load water lines are to be established under regulations issued from time to time by the Secretary of Commerce and shall indicate the maximum depth to which vessels safely may be loaded.

The master and the owner of the vessel are required to keep these load water lines permanently and conspicuously marked on the vessel as required by the regulations. The marking of these load lines is to be under the supervision, so far as their position and manner of marking is concerned, of the American Bureau of Shipping or other proper association selected by the Secretary of Commerce. If the ship-owner desires, he may request the Secretary of Commerce to appoint any other corporation or association satisfactory to the Secretary of Commerce for the purpose. The Secretary of Commerce also has authority to appoint any officer of the Government for this purpose.

In the case of foreign vessels leaving our ports authority is given the Secretary of Commerce to accept the load line placed under laws

and regulations of the country to which they belong provided such laws and regulations are equally effective with those established under this act. If they are not as effective as our law requires, load lines must be placed on such vessels under the rules and regulations of the Secretary of Commerce.

It is unlawful for any vessel subject to the act to be so loaded as to submerge in sea water these load-line marks.

Provisions are made for the administration of the law and regulations and heavy penalties are provided for their violation.

The requirement that the administration of this law in the field shall be through the American Bureau of Shipping is of prime importance as it is essential to our merchant marine that this American classifying and rating society should have the support of the Government and American shipowners generally.

The law does not go into effect for 18 months after its approval. In the meantime the committee appointed by this department has held and is holding hearings and preparing for submission to you for consideration and possible approval regulations based on the most advanced practices of maritime nations for carrying the act into effect.

It will be noted that the above law does not apply to our coastwise trade or to traffic on the Great Lakes.

On March 1 last, just before adjournment, the Senate passed the following resolution (S. Res. 345, 70th Cong., 2d sess.):

Resolved, That the Secretary of Commerce is requested to make a comprehensive study of load-line legislation in the coastwise and intercoastal trade and on the Great Lakes and of all types of vessels, and to submit his report covering the same to the Senate during the month of December, 1929, and to accompany such report with a tentative draft of a bill to effectuate his recommendations.

In order to make a proper study of the complicated questions covered by this resolution, extensive hearings covering navigation on the Atlantic, Pacific, and Gulf coasts, and the Great Lakes would be involved. There was no opportunity for an appropriation to be made for this purpose, and the department necessarily will be handicapped somewhat in complying fully with the wishes of the Senate. The matter, however, has been given some consideration inasmuch as when the bill (S. 1781) which later became law was before the Committee on Merchant Marine and Fisheries of the House, the application of the bill to the coastwise trade and the trade on the Great Lakes was gone into to some extent.

INTERNATIONAL CONVENTION ON SAFETY OF LIFE AT SEA

The International Conference on Safety of Life at Sea met in London from April 16 to May 31, 1929, when a comprehensive convention was signed by the United States and the following 17 foreign maritime nations: Belgium, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Norway, Russia, Spain, Sweden, and the delegations of Great Britain, Canada, Australia, Irish Free State, and India.

This convention doubtless will be transmitted to the Senate at the next regular session for the advice and consent of that body to its ratification.

This international convention undoubtedly is the most important step ever taken by maritime nations to promote the safety of life at sea, and it is to be trusted that the Senate will consent to its ratification. The limited space available in this report precludes a detailed statement of the work of this convention. It may be stated generally, however, that this convention was engaged in perfecting a great work which can not but be of lasting benefit to mankind. The spirit of courtesy and conciliation displayed throughout the conference contributed greatly to the increase of mutual respect and confidence among the nations. The United States delegation, of course, encountered a wide diversity of interest—economic, practical, and humanitarian—among the other delegations. Out of this conflict, however, there grew up a standard of hull construction, equipment, and navigation in practically all respects a material advance over existing international practice or local legislation.

Preparatory to the conference, committees designated by the Department of Commerce for more than a year gave extensive study to preparing a standard of hull construction, equipment, and navigation that would secure the highest degree of safety to passengers and crew. Those taking the leading and most active part in these committee meetings were appointed as delegates to the conference or as their technical advisers. As a result of this preliminary work the United States delegates at London undoubtedly influenced to a considerable extent the results which were attained.

ADMEASUREMENT OF VESSELS

The necessity for the establishment in the interests of our merchant marine of a proper admeasurement service in this country is growing more and more apparent.

At the time the Bureau of Navigation was transferred from the Treasury Department to the Department of Commerce it was not deemed feasible to segregate that portion of the clerical force in the customhouses employed on marine work from those engaged in collecting and safeguarding the public revenue.

It therefore became necessary for the Commissioner of Navigation, charged by statute with the admeasurement of vessels, to perform his duties through employees selected, paid, and rewarded for efficient service or demoted by the Treasury Department.

Under such an unbusinesslike organization we have been unable to secure uniformity and accuracy in the admeasurement of our vessels which is essential in these days of close competition on the sea. On her admeasurement a vessel pays canal tolls, tonnage taxes, in some cases pilotage and port dues of numerous kinds both in America and foreign ports, and an error in her admeasurement is a handicap to that vessel wherever she may go.

It is obvious that there should be established an admeasurement service composed of trained admeasurers under the direct control of the department charged with this service. Centralization of the work in this department will greatly improve the service at all ports; it will engender professional pride; remove the work to a large extent from local influences; consolidate efforts and secure more responsive action; all of which will tend to attract to the service competent men who through central direction will render impartial and adequate

work to the credit of the department and the benefit of shipowners. The shipowners will have standard service and, should it be desired, expert advice in the construction of vessels on points of law regarding tonnage, thereby preventing delay and expense due to changes that later they might find necessary to get all the benefits of deductions and exemptions provided in the law. The Panama Canal authorities have expressed their views that such service should be instituted as soon as practicable, as the variation in methods in admeasurement at our various ports is reflected in the work at the canal.

In Great Britain the subject of admeasurement is considered of sufficient importance to require a long apprenticeship before a man is considered qualified to measure a vessel, and the compensation of the admeasurers is considerably above that provided in this country.

With your permission I hope to present to you a form of proposed legislation to effectuate the above suggestions. This service is closely related to the administration of the load line law. Shipowners and shipbuilders are urging the organization of an efficient admeasurement service and I feel justified in emphasizing the necessity for legislation on this subject at an early date.

The necessity for uniform and accurate admeasurement of vessels has received international consideration, and the League of Nations at Geneva appointed a technical committee for maritime tonnage measurement made up of representatives of the various maritime nations, a representative of the United States attending. It is expected in the near future that there will be a formal international conference on the subject, and as this country has, next to Great Britain, the largest seagoing tonnage of any maritime nation, it is essential that we should be represented at that conference. The United States will be in a much stronger position if its delegates have behind them a properly organized admeasurement service qualified to support its views on the subject.

During the year our officers admeasured 1,387 vessels of 272,592 tons. The outlook for the next fiscal year is considerably brighter, especially as regards large freight and passenger vessels, there being under construction 15 vessels of more than 1,000 tons with an estimated aggregate of more than 100,000 gross tons. Contracts for other construction are under consideration.

Owing to changes in construction and for other reasons the tonnage of 416 vessels of 547,701 gross tons was changed during the year, requiring admeasurement. There are 44 customs districts employing something less than 200 men engaged in the work a whole or a part of the time. The present cost of admeasurement work in salaries approximates \$76,000.

ADMINISTRATION OF THE NAVIGATION LAWS

I desire again to bring to your attention the importance of the reorganization of our field services. As stated last year the ownership of vessel property and its use, both national and international, are closely regulated by Federal law. At the beginning of our Government the administration of these laws was intrusted to collectors of customs, acting under the instruction of the Secretary of the Treasury, as those officers located at every port of entry were easily accessible to the shipmaster and owner.

On the creation of the Department of Commerce this administration, which directly affects the movement of commerce, was transferred to that department, but the employees and machinery necessary to such administration were left in the Treasury Department, where they are now functioning under the direction of the Secretary of Commerce.

This creates the anomalous situation of the employment by the Treasury Department of personnel and the regulation of administrative machinery to perform duties under the jurisdiction of the Department of Commerce and for which the Secretary of the latter department is responsible.

The laws administered by the marine divisions of the customhouses are voluminous, technical, and complicated. Their proper administration affects the title to all vessel property, its prompt turn around in our ports, the safety of passengers and crew, and the health and welfare of immigrants and of the crews manning our ships.

It would be difficult to imagine any corporation successfully carrying on its business with a personnel selected, remunerated, rewarded, or penalized by an association engaged in an entirely different line of effort.

The solution, of course, is the transfer to the Department of Commerce of the personnel engaged on this work. More and more evidences are accumulating of the disadvantage of the present system to our merchant marine as new laws are enacted placing in the Department of Commerce added duties and responsibilities.

ENFORCEMENT OF THE NAVIGATION LAWS

The work of general enforcement of the navigation laws has proceeded throughout the year along regularly established lines. The cooperation of shipping interests in complying with the requirements of the law continues. These laws are voluminous and cover practically every operation of the vessel from the time she is contracted to be built until she is finally abandoned or sold foreign. The Coast Guard service with its widespread and efficient organization has brought to the attention of the department a number of violations of the law, especially in the case of smaller vessels, and has rendered excellent service in patrolling the course during regattas and marine parades. The department's patrol fleet has been active and the customhouse and navigation inspector facilities are reporting an increasing compliance with the law.

There were reported during the year 7,887 violations of the various statutes which we administer. This does not include a large number of highly technical violations which were not entered on the books of collectors of customs as fine cases, the department handling these violations directly and in such a way as to secure compliance with the law without the needless imposition of penalties. There has been a constant endeavor on the part of our enforcement agencies to enlist the assistance and good will of vessel owners, and the bureau feels justified in claiming that there is at the present time a closer compliance with the navigation laws than has been the case for many years.

Of the violations reported, 3,873 or nearly half of the total number were of small vessels of which there are about 250,000 on navigable

waters. These small vessels are used by millions of people for commercial and pleasure purposes, hence their equipment is important. They are peculiarly subject to accidents on account of their small size and because in the waters where they navigate there often are floating objects which they may strike. The increase in the violations of the passenger act over recent years is perhaps due to a closer administration of the law. The defects reported, however, have not been of a serious nature and it is a matter of common knowledge that the quarters devoted to the transportation of steerage passengers are in all respects far in advance of those provided when the law went into effect in 1882.

The following table shows the enforcement of such laws by customs districts and laws violated, followed by a comparison with the work of previous years:

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Table showing, by ports, the navigation laws violated and the number of violations during the year ended June 30, 1929

Headquarters port	Total	Steam-boat laws (R. S. 4399-4500, U. S. C. Title 46, secs. 361-498)	Motor-boat laws (36 Stat. 462, U. S. C. 511-519) "Rules of road" (26 Stat. 320-328, 28 Stat. 645-650, 29 Stat. 690-691, U. S. C. Title 33, secs. 61-351)	Surrendered license (R. S. 4325-4326, U. S. C. Title 46, secs. 267-268)	Seamen's act (38 Stat. 1109, 1164, U. S. C. Title 46, secs. 672-673)	Anchor- age and St. Marys River rules (29 Stat. 54, 34 Stat. 136, U. S. C. Title 33, sec. 474)	Passen- ger act (22 Stat. 186-191, U. S. C. Title 46, secs. 151-162, 171)	Enroll- ment and license (R. S. 4336, U. S. C. Title 46, sec. 277)	Entry and clearance (R. S. 4197, U. S. C. Title 46, sec. 91)	Name on vessel (R. S. 4178, U. S. C. Title 46, sec. 46)	Change of master (R. S. 4335, U. S. C. Title 46, sec. 276)	Unlading (R. S. 4351, 4355, U. S. C. Title 46, secs. 296, 300)	Num-bering act (40 Stat. 602, U. S. C. Title 46, secs. 283-289)	Miscel- laneous
Baltimore.....	517	73	335	11				1		19			70	8
Boston.....	534	49	266	48			3	19	2	14	3	2	89	39
Bridgeport.....	199	7	118	37				9	2	6	1		17	2
Buffalo.....	103	15	69		3			2		1		1	12	
Charleston.....	57	1	25	25				1		1			4	
Chicago.....	68	8	32	13	3						1		11	
Cleveland.....	144	10	92	13	1	3		2	4	1	1		14	3
Detroit.....	202	10	118	27		2			9				31	4
Duluth.....	46	3	27	1	1			3	8				2	1
Galveston.....	14		1	6				3					4	
Great Falls.....	1							1						
Honolulu.....	14		3	2							1		6	2
Indianapolis.....	8		8											
Juneau.....	55	2	4	25				4	2	2	1	7	8	
Los Angeles.....	405	45	70	39	1			8	18		1	3	27	193
Louisville.....	44		25	17							1		2	
Memphis.....	81		21	22				3		11			24	
Milwaukee.....	25		11	8									6	
Mobile.....	186	3	59	57				4		18	1	1	35	8
New Orleans.....	226	18	57	55				5	17	9	6		53	6
New York.....	1,233	29	822	230				14	1	32	7		80	18
Nogales.....	9													9
Norfolk.....	354	14	171	62	1			12	1	24	2		56	11
Ogdensburg.....	87		65	14						1			7	
Omaha.....	2			2										
Pembina.....	1			1										
Philadelphia.....	465	10	265	54	1			13		9	1		110	3
Pittsburgh.....	43	4		28				1					9	1
Port Arthur.....	29	3	5	15				1					5	
Portland, Me.....	337	9	241	20						10			56	1

Portland, Oreg.....	125	1	71	15				2	1	3			30	2
Providence.....	113	1	89	6				1		4	1		11	
Rochester.....	34	1	29							1	1		2	
St. Louis.....	46	1	26							1			19	
San Antonio.....	34		3	8									28	
San Francisco.....	227	18	55	45			4	20	9	10	5	5	33	22
San Juan.....	25	1	4	8	1			1	7	1		1	1	1
Savannah.....	95		7	75					1				10	2
Seattle.....	290	23	67	62			9	3	19	5	2	14	67	29
Tampa.....	1,075	6	333	80				36	244	13			335	28
Wilmington, N. C.....	333	10	221	20				8		3	2		61	8
Total—														
1929 (41 ports).....	7,887	375	3,873	1,078	13	5	16	177	345	198	37	34	1,335	401
1928 (40 ports).....	8,643	534	3,537	1,070	21	3	12	295	821	145	34	21	1,869	281
1927 (39 ports).....	8,306	654	3,244	1,130	21	2	2	283	464	197	77	22	1,983	227
1926 (39 ports).....	10,778	2,501	3,722	1,330	47	3	9	178	272	285	83	18	2,080	248
1925 (40 ports).....	9,544	922	3,487	1,446	34	4	5	453	238	224	92	16	2,374	249
1924 (40 ports).....	8,867	547	2,782	1,069	104	55	18	185	116	445	78	16	3,201	250
1923 (40 ports).....	11,251	695	3,069	945	405	11	10	1,130	79	505	49	17	4,117	215
1922 (41 ports).....	11,412	422	4,614	944	75		27	59	71	443	56	110	4,426	158
1921 (42 ports).....	10,707	840	3,772	974	250		48	45	100	673	68	42	3,676	208
1920 (41 ports).....	10,867	2,650	2,530	988	514		16	38	104	267	39	118	3,192	160
1919 (40 ports).....	8,173	1,589	2,397	1,066	273		28	38	83	196	32	83	2,244	86
1918 (49 ports).....	4,749	710	2,337	922	160		32	20	62	127	27	250		82
1917 (48 ports).....	7,569	1,020	4,660	770	286		29	42	43	400	41	74		182
1916 (48 ports).....	7,825	812	5,126	943	271		19	59	28	331	35	67		90
1915 (48 ports).....	6,868	671	4,462	982		11	10	104	41	348	67	93		42
1914 (49 ports).....	6,720	768	4,838	631		8	25	41	26	153	59	90		45
1913 (107 ports).....	3,506	333	2,783	23		23	8	24	10	83	26	1		152
1912 (105 ports).....	3,634	165	3,119	96		12	17	38	39	81	12			55
1911 (92 ports).....	2,268	182	1,811	17		17	45	10	16	43	30			91
1910 (74 ports).....	1,070	252	488	23		13	61	13	16	68	12	2		128
1909 (64 ports).....	1,134	151	710	33		3	21	14	7	59		4		132
1908 (73 ports).....		245	385	12		6	21	23	18	30	7	2		103
1907 (66 ports).....	684	209	92	88		18	62	9	23	52	27	5		99
1906 (77 ports).....	670	194	130	114		13	27	10	6	49	5	9		113
1905 (63 ports).....	524	142	53	99		13	21	26	7	20	11	28		104
1904 (66 ports).....	706	184	93	101		49	16	29	12	24	19	(1)		179

¹ Included under "Miscellaneous" in 1904 report.

The following table shows the work done by the various branches of the service engaged in the enforcement of the navigation laws in comparison with previous years:

Headquarters port	Total	Kilken-ny	Tarra-gon	Dixie	Siwash	Psyche	Coast Guard	Local in-spectors	Cus-toms	Navi-gation in-spectors
Baltimore	517	484				5	1	13	14	
Boston	534				268		89	33	204	
Bridgeport	199				141		14	1	43	
Buffalo	103					58	22	11	12	
Charleston	57		18	2			9		28	
Chicago	68						7	11	23	27
Cleveland	144					57	24	11	29	23
Detroit	202						40	11	151	
Duluth	46						7		12	27
Galveston	14								14	
Great Falls	1							1		
Honolulu	14								14	
Indianapolis	8									8
Juneau	55						7		48	
Los Angeles	405						7	35	281	82
Louisville	44								17	27
Memphis	81			17					45	19
Milwaukee	25						17		8	
Mobile	186				112			2	72	
New Orleans	226			105			19	13	89	
New York	1,233				591	218	140	13	271	
Nogales	9								9	
Norfolk	354	211				32	44	9	58	
Ogdensburg	87					40	7		40	
Omaha	2								2	
Pembina	1								1	
Philadelphia	466	248				4	75	5	134	
Pittsburgh	43							3	40	
Port Arthur	29								29	
Portland, Me.	337				234		26	6	71	
Portland, Oreg.	125						25	17	31	52
Providence	113					48	20	1	8	36
Rochester	34						6		20	
St. Louis	46						8		38	
San Antonio	34								34	
San Francisco	227						86	15	126	
San Juan	25								25	
Savannah	95		62				2		31	
Seattle	290								212	31
Tampa	1,675		147	59			250		619	
Wilmington, N. C.	333	17				127	174		15	
Total—										
1929 (41 ports)	7,887	960	227	295	1,222	547	1,167	211	2,868	360
1928 (40 ports)	8,643	1,009	144	268	1,537	596	1,019	321	3,397	352
1927 (39 ports)	8,306	743	368	69	1,176	400	1,548	423	3,327	352
1926 (39 ports)	10,778	987	387	315	941	1,909	1,504	245	3,548	941
1925 (40 ports)	9,544	472	401	515	970	874	1,179	222	4,040	871
1924 (40 ports)	8,867	1,192	787	1,078	671	586	616	327	3,312	297
1923 (40 ports)	11,251	1,332	829	1,111	1,060	1,172	521	799	3,883	540
1922 (41 ports)	11,396	1,184	999	764	1,275	2,500	509	317	3,203	630
1921 (42 ports)	10,706	1,637	1,112	1,182	712	479	404	773	3,869	529
1920 (42 ports)	10,667	1,303	1,261	41			300	2,083	5,028	626
1919 (41 ports)	7,582	1,480	1,226				235	767	3,114	554
1918 (49 ports)	4,893	84	809				241	404	2,654	696
1917 (48 ports)	7,565		1,234	364			1,255	712	2,833	654
1916 (48 ports)	7,895		987	984			1,333	590	2,876	1,089
1915 (48 ports)	6,860		1,425				1,380	361	2,661	999

Of the 7,887 violations reported, 3,251 were discovered by the various five patrol boats which operate along the Atlantic and Gulf coasts and for the summer months on the Great Lakes. This does not give a complete index of the work of the boats as during the year they made 29,645 inspections and the violations reported indicate that 1 violation was discovered in each 10 inspections. When it is recalled that all violations, no matter how technical, are reported to the department, a fair idea can be given of the extent to which our inspection service has secured compliance with the law. It is a matter of

congratulation that reports are received of very few cases of loss of life due to lack of equipment on these vessels, in strong contrast to conditions which existed some years ago before our motor-boat equipment laws were in effect.

Following is a comparative statement of cases of violations of the navigation laws reported by officers of customs, 1915-1929:

Comparative statement of cases of violations of the navigation and steamboat inspection laws reported by officers of customs, 1915-1929

Port	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929
Baltimore	396	312	461	265	500	663	690	482	480	419	161	300	361	551	517
Boston	440	412	427	194	243	626	607	898	711	566	767	800	833	513	534
Bridgeport	118	54	89	32	95	97	200	50	287	131	206	131	310	231	199
Buffalo	42	144	87	111	168	143	188	62	116	262	90	24	34	257	103
Charleston	91	39	50	28	109	40	44	68	192	136	105	82	110	82	57
Chicago	178	389	283	144	88	119	171	97	179	165	139	76	97	30	68
Cleveland	104	218	161	177	499	1,096	252	160	154	303	187	97	84	168	144
Des Moines	85	4	116	56	27	40	141	32	62	48	11			3	
Detroit	293	441	163	146	142	122	168	67	184	311	80	83	184	182	202
Duluth	62	79	138	132	282	241	73	68	245	79	44	42	38	33	46
Eagle Pass			1	1											
Galveston	49	50	105	54	21	24	41	8	10	167	78	57	26	31	14
Great Falls										3					1
Honolulu	14	18	18	11	10	3	95	35	22	16	45	10	12	18	14
Indianapolis	5	109	54	85	32	34	29	37	3	2	4		7	4	5
Juneau	43	33	40	44	43	39	60	36	77	130	106	78	51	45	88
Laredo	2	7	10												
Los Angeles	182	172	137	109	192	125	183	185	178	131	127	171	261	281	405
Louisville	58	63	128	50	49	64	35	57	29	26	23	54	35	18	44
Memphis	52	94	84	18	67	83	66	86	62	162	150	154	120	49	81
Milwaukee	8	133	82	18	81	133	33	14	79	17	5	7	104	1	25
Mobile	107	106	109	52	98	122	301	203	334	294	191	96	263	42	186
New Orleans	173	177	315	221	501	487	779	294	467	790	371	411	186	285	226
New York	622	1,256	1,292	583	626	1,349	849	2,698	1,475	663	1,625	2,454	1,185	1,170	1,233
Nogales				22		8	21	13		7	12	10	14	3	9
Norfolk	335	531	430	181	814	618	846	680	682	412	375	842	434	345	354
Ogdensburg	40	92	74	201	54	18	8	85	85	18	112	58	142	50	87
Omaha							1							2	2
Pembina				3											1
Philadelphia	867	483	406	166	532	600	684	778	624	360	854	549	303	493	466
Pittsburgh	13	27	4	6	9	28	16	22	14	41	35	16	53	39	43
Port Arthur	33	68	93	117	203	256	112	21	17	216	84	52	15	61	29
Portland, Me.	566	241	145	51	53	55	320	346	440	295	393	684	159	645	337
Portland, Oreg.	273	229	130	239	120	182	107	83	101	171	291	237	84	100	125
Providence	21	125	94	68	65	137	175	181	98	94	144	169	217	104	113
Rochester	28	42	44	102	14	24	55	10	61	57	53	18	24	130	34
St. Albans	3	33	68	29	1	1	8	96	2	4	4	22			
St. Louis	186	154	348	173	201	396	182	173	179	127	89	100	64	57	46
St. Paul	1	5			4							1			
San Antonio				2	2	7	9	10	25	23	28	15	8	9	34
San Diego					1	22	34	32							
San Francisco	440	276	196	151	223	765	466	213	291	288	284	281	238	277	227
San Juan	28	11	12	14	8	14	10	14	19	18	26	25	22	23	25
Savannah	78	82	48	41	77	68	149	165	163	126	126	67	47	60	95
Seattle	306	409	318	338	266	320	310	272	1,223	294	564	755	328	390	290
Tampa	314	570	547	295	1,303	1,247	1,770	2,300	1,649	1,386	1,398	1,690	1,519	1,609	1,075
Wilmington, N. C.	206	137	262	19	261	302	426	263	200	173	152	78	312	282	333
Total (47 ports)	6,868	7,826	7,569	4,749	8,173	10,667	10,706	11,396	11,251	8,867	9,544	10,778	8,306	8,643	7,887

¹ The districts of Laredo (No. 23) and Eagle Pass (No. 25) were abolished by Executive order Sept. 7, 1917, and the district of San Antonio (No. 23) was created by the same order.

² The districts of Los Angeles and San Diego were consolidated by Executive order of Jan. 26, 1923, with Los Angeles as headquarters port.

PREVENTING OVERCROWDING OF PASSENGER VESSELS

The work of preventing the overcrowding of excursion vessels has proceeded along the usual lines, the number of persons using this form of recreation having increased to some extent. It is gratifying to note that throughout the United States there has not been reported a single case of overloading of excursion vessels subject to the inspection laws. This is in strong contrast to the conditions which existed before Congress made provision for the close supervision of this service.

The following table shows the counts made by the navigation and customs services by ports:

Number of counts and the number of passengers involved in preventing overcrowding of passenger vessels during fiscal year 1929

Port	Navigation		Customs		Total	
	Counts	Passengers	Counts	Passengers	Counts	Passengers
Baltimore.....	1,522	496,527	1	682	1,523	497,209
Boston.....	34	31,110	347	265,319	381	296,438
Bridgeport.....			3	3,227	3	3,227
Chicago.....	2,248	413,230	73	36,756	2,321	449,986
Cleveland.....	333	392,055	183	140,939	566	532,994
Detroit.....	922	1,187,163	10	8,263	932	1,195,426
Duluth.....		18,001				18,001
Galveston.....			74	6,804	74	6,804
Indianapolis.....	2	1,040	12	9,917	14	10,957
Louisville.....	169	125,493			169	125,493
Memphis.....	3	318	1	656	4	974
New York.....			885	2,000,713	885	2,000,713
Norfolk.....	620	109,073	2	77	622	109,150
Philadelphia.....			221	172,545	221	172,545
Portland, Me.....	438	63,101			438	63,101
Rochester.....	64	14,152			64	14,152
Seattle.....	178	36,975	58	2,686	236	39,661
Total, 1929.....	6,583	2,888,247	1,870	2,648,584	8,453	5,536,831
Total, 1928.....	7,171	2,708,132	3,059	2,376,979	10,230	5,085,111

When a vessel is inspected and equipped to carry passengers, there is inserted in her certificate of inspection the maximum number of passengers which she may carry with safety. In the administration of the law preventing the overcrowding of such vessels the inspectors determine from the certificate the number of passengers which the particular vessel may carry. These inspectors are equipped with automatic counting devices and passengers are not permitted to go on board except under the count of these inspectors. When the limit of passengers set by the certificate of inspection has been reached, the inspectors then notify the officers of the vessels who prevent any more passengers going on board.

During the year it was necessary for the inspectors in 177 cases to take such action. This involved the safety of 169,875 passengers.

The following table shows in detail the occasions when the limit of safety had been reached before all the passengers had embarked:

Shut-offs, by specified months

Port	July, 1928		August, 1928		September, 1928		May, 1929		June, 1929		Total	
	Counts	Passengers	Counts	Passengers	Counts	Passengers	Counts	Passengers	Counts	Passengers	Counts	Passengers
Baltimore.....	2	2,150	4	5,200					2	1,650	8	9,000
Boston.....	2	3,300	1	1,650	1	1,650					4	6,600
Chicago.....	33	11,090	8	2,271			7	2,124	4	1,094	52	16,579
Cleveland.....	7	12,260	9	12,671							16	24,931
Detroit.....	17	44,102	9	27,706			2	5,016	6	14,024	34	91,848
Louisville.....	2	1,600									2	1,600
New York.....									44	12,020	44	12,020
Norfolk.....	10	3,139	1	615							11	3,754
Philadelphia.....	2	1,505	2	2,010							4	3,515
Seattle.....	2	28									2	28
Total, 1929.....	77	79,174	34	52,123	1	1,650	9	8,140	56	28,788	177	169,875
Total, 1928.....	136	94,866	27	37,045	4	519	6	19,548	60	38,696	223	190,674

SHIPPING COMMISSIONERS

During the year 627,392 seamen were shipped, reshipped, and discharged as compared with 547,732 the year before. The average cost to the Government per man was 22 cents, a reduction of 1 cent per man over the previous year.

Collectors of customs acting at ports where shipping commissioner offices have not been established shipped and discharged during the year 47,562 officers and men as compared with 73,042 during the previous year.

Of the 325,120 men shipped before shipping commissioners 160,397 were native Americans and 48,814 were naturalized Americans: 209,211 in all, or 64.3 per cent. This does not give an accurate idea of nationality of crews of our vessels, as under existing law vessels may sign on a portion of their crews in foreign ports before United States consuls for the round trip. These men do not appear before our shipping commissioners and are not included in the following table which shows the aggregate work and salaries of the shipping commissioner service for the past 12 years:

Year	Seamen shipped, reshipped, and discharged	Salaries	Average cost per man	Year	Seamen shipped, reshipped, and discharged	Salaries	Average cost per man
1918.....	457,248	\$72,075	\$0.16	1924.....	555,633	\$94,476	\$0.17
1919.....	485,796	72,288	.15	1925.....	552,124	123,726	.22
1920.....	628,980	89,949	.13	1926.....	534,493	123,183	.23
1921.....	650,840	99,646	.15	1927.....	561,061	122,398	.22
1922.....	541,952	92,318	.17	1928.....	547,732	123,961	.23
1923.....	538,755	94,476	.17	1929.....	627,392	139,454	.22

The above work involves the supervision of the contracts of employment by seamen and under the existing practice such supervision results in the protection of the rights of seamen under the laws. Our statutes have extended to such seamen wide protection covering their wages, length of employment, character of the voyage, the food required, their quarters, and care in foreign ports when sick or disabled. Should a seaman die while abroad, his wages and effects are cared for by the master of the vessel who turns them over to the shipping commissioner on the vessel's return. During the year shipping commissioners received \$121,429 in deceased seamen's wages, unclaimed wages, and deserters' wages. The commissioners are under heavy bond and are personally responsible for this money.

PASSENGER ACT OF 1882

The improved conditions of the accommodations extended to steerage passengers in recent years is a very material improvement over the conditions which existed when the passenger act of 1882 regulating such transportation was passed. Under that act Congress provided in detail for the space to be provided each passenger, its ventilation and cleanliness, hospital spaces, eating accommodations, the separation of the sexes, and general supervision of moral conditions, medical facilities and attendance, and in other ways so far as possible protected the health and welfare of its future citizens.

The following table shows the number of steerage passengers brought to our ports each year since 1924 on steam vessels inspected for this purpose and the number of voyages made by such vessels:

Year	Voyages	Steerage passengers	Year	Voyages	Steerage passengers
1924.....	1,235	348,989	1927.....	1,367	275,175
1925.....	1,257	187,127	1928.....	1,384	301,223
1926.....	1,334	215,639	1929.....	1,422	327,018

NAVIGATION RECEIPTS

Revenue collected by the bureau from all sources during the year aggregated \$2,318,651.17. Attention again is invited to the fact that the amounts thus collected from our merchant marine exceeded by nearly \$800,000 the entire expense of the Bureau of Navigation and the Steamboat Inspection Service combined.

These receipts in detail were as follows:

June 30—	Tonnage duties	Navigation fees	Navigation fines	Total
1929.....	\$2,014,438.06	\$249,483.21	\$54,729.90	\$2,318,651.17
1928.....	1,939,289.98	228,089.07	87,269.14	2,254,648.19
1917.....	1,393,743.16	159,808.03	49,962.37	1,603,513.56

PUBLICATIONS

Publications of the bureau comprise the Navigation Laws (quadrennial with annual pamphlet supplements), Merchant Vessels of the United States (annual), Code List of Merchant Vessels (annual), and American Documented Seagoing Vessels of 500 Gross Tons and Over (monthly).

Appendixes and statistics of the merchant marine formerly printed as a part of the bureau's annual report are now published as a separate document known as Merchant Marine Statistics.

The above publications are no longer issued gratuitously, but are for sale by the Superintendent of Documents, Government Printing Office, Washington, D. C.

In addition to the above, the bureau issues regulations covering the navigation of the St. Marys River, the admeasurement of vessels, navigation and equipping of small motor boats, recording of mortgages and bills of sale, regulations governing regattas and marine parades, and various other administrative subjects.

Very truly yours,

A. J. TYRER,
Commissioner of Navigation.

STEAMBOAT INSPECTION SERVICE

DEPARTMENT OF COMMERCE,
STEAMBOAT INSPECTION SERVICE,
Washington, July 1, 1929.

The honorable the SECRETARY OF COMMERCE.

DEAR MR. SECRETARY: Herewith is submitted the report of the Steamboat Inspection Service for the fiscal year ended June 30, 1929.

PERSONNEL

The following positions were embraced in the service at the end of June, 1929:

Central office:

Supervising Inspector General.....	1
Deputy Supervising Inspector General.....	1
Administrative assistant.....	1
Traveling inspectors.....	6
Clerks.....	12
Messenger.....	1
Total, central office.....	22

Field:

Supervising inspectors.....	11
Local inspectors of hulls.....	46
Local inspectors of boilers.....	46
Assistant inspectors of hulls.....	75
Assistant inspectors of boilers.....	75
Clerks.....	92
Total, field.....	345
Grand total.....	367

A GREATER SERVICE

There must be a material expansion of the Steamboat Inspection Service to meet the modern requirements of the law and to carry out the provisions adopted at the International Conference on Safety of Life at Sea in London in 1929. It is likewise necessary to have a larger number of inspectors to make more thorough annual inspections and more frequent reinspections.

A CENTRAL STAFF

To properly carry out the provisions of section 4403, Revised Statutes, the Supervising Inspector General must have at Washington a central organization of technical experts who are competent to pass upon the construction of hulls and boilers from an accurately scientific point of view. Under section 4417, Revised Statutes, the responsibility for determining whether a vessel is of a construction

suitable for the service in which she is to be employed rests upon the boards of local inspectors. Under section 4418, Revised Statutes, responsibility rests upon the local inspectors with regard to the approval of boiler designs. Those two sections, however, must be read with section 4403, Revised Statutes, which requires the Supervising Inspector General to produce a correct and uniform administration of the inspection laws, rules, and regulations. This uniformity can be better obtained if the Supervising Inspector General has a central staff passing upon hull and boiler construction and advising the local districts of the result. Under present circumstances, with 47 different boards of local inspectors acting, there may be 47 different opinions and conclusions that are not in keeping with the General Rules and Regulations.

MORE INSPECTORS AND CLERKS

The work in the central office is congested by reason of an insufficient clerical staff. Earnest representations were made last fall for six additional clerks, and the request will be repeated in the estimates for the fiscal year ending June 30, 1931. More clerks are also needed in the field.

Fifty more inspectors are urgently needed to make annual inspections thoroughly and to make more frequent reinspections. Inspectors are required to make three reinspections a year, or during the season of navigation, of ferry and excursions steamers, but this work is not being kept up because there are not enough inspectors. More inspectors are also needed to make reinspections more frequently of ocean liners. Criticisms have been made of the infrequency of such inspections.

THE BOARD OF SUPERVISING INSPECTORS

The Board of Supervising Inspectors made great progress at its last annual meeting in January in bringing the General Rules and Regulations up to date to meet modern conditions and provide greater safety. The unfortunate disaster to the British steamer *Vestris* made necessary a special inquiry into the facts. Much testimony was taken and a detailed report submitted, which was printed as Senate Document No. 191. The Board of Supervising Inspectors considered the recommendations contained therein and made the following more important provisions at the last board meeting:

1. Rule III was amended to require a lifeboat lowering test.
2. Rule III was also amended to require the testing of crew in pulling the oars in ships' lifeboats.
3. A revision was made of Rule V by raising the standard of examinations given for the various grades of licenses.
4. A rule for the testing of releasing hooks was agreed upon.
5. Thorough investigation was made with reference to life preservers, but as nothing could be arrived at that was deemed superior to the present type no change was made.
6. A revision was made in the forms of inspection books to make them more complete and to cover the various changes to meet the new requirements for inspections.
7. A requirement for the physical examination of licensed officers was provided.

8. Requirements were made with reference to scuppers, sanitary, and other similar discharge pipes.

While not growing out of the *Vestris* disaster, other matters were considered to bring the service abreast of modern practice. They are, briefly, as follows:

1. Section 4, Rule VII, General Rules and Regulations, was amended to require a greater number of life preservers to be carried on ferryboats.

2. A tentative revision was made of Rule I, covering material for boilers, and of Rule II, covering their construction, inspection, appurtenances, etc.

3. A rule for testing gravity davits was adopted.

4. For several years attention has been given to drafting a rule covering fire detection and alarm on vessels, and specifications were agreed to on this.

5. An investigation and change was made with reference to the credit to be given different kinds of fire extinguishers on board ship.

6. The board checked up and agreed to examinations formulated to be used as standards by the local inspectors in the examination of applicants for license.

7. Specifications for efficient distress signals were adopted.

The board considered the reliability of releasing hooks that have from time to time been approved by the board or executive committees, and agreed that during the present calendar year, probably in the fall, tests were to be made of all types of releasing hooks that are installed on vessels subject to inspection. These hooks will be tested by a select committee of the board and the result considered at its next session.

The question as to the rating to be given different types of life floats will be carefully considered by the select committee called to test releasing hooks, and its report will be considered by the board at its next annual meeting.

REVISION OF BOILER RULES

Reference has been made to the tentative revision of Rules I and II, General Rules and Regulations, covering boiler material and the construction, inspection, appurtenances, etc., of boilers. The proposed revision was furnished to interested persons for criticism, suggestions, and comment. Many important concerns have been heard from favorably, and their helpful suggestions will assist in perfecting the rules for consideration by the Board of Supervising Inspectors at its session next year. A big step has been taken to make the marine-boiler rules of this country second to none in the world. When the rules are agreed upon, a report will be made on the legislation needed.

In the revision of Rules I and II the bureau had a representative confer personally with representatives of the various large valve manufacturing companies, with a view to drafting the best requirements that could be formulated covering valves and fittings. While those provisions are not yet perfect, it is believed they represent a material advance.

Reference should also be made to the revision of that part of Rule II covering the specifications for the manufacture of fusible plugs and to the able work by the Bureau of Standards in its recommendations.

A study and investigation are being made of developments in the methods of electrical installations on board ship, in order that the regulations may cover them as far as necessary.

Reference has been made to the Board of Supervising Inspectors passing upon standard sets of examination questions for use by the local inspectors in conducting examinations of applicants for license. While it is not the intention that the exact questions and answers be used, it will be the instruction of the bureau that questions of like value be given, so that examinations may not only be uniform but that the standard of personnel may be raised.

MOTOR VESSEL INSPECTION

Something should be done about the expansion of motor-boat inspection and officering. To issue operators' licenses under the act of June 9, 1910, is to place a premium upon carelessness and incompetency and to give the approval of the United States Government to something that is inherently wrong. These operators should be required to be properly examined by the Steamboat Inspection Service concerning, at least, their visual acuity, color sense, and knowledge of the rules of the road. They should be 21 years of age and required to be citizens of the United States—a minor may now hold such a license and it is not required that he be an American citizen. The inspection of the boats should be extended to make conditions safer upon vessels that are not now inspected, and to give the inspectors some real authority concerning vessels of the motor type that are now subject to inspection.

EXPENDITURES

Following is a detailed account of the expenditures for the year ended June 30, 1929:

Salaries, Supervising Inspector General, Deputy Supervising Inspector General, supervising and local inspectors, assistant inspectors, traveling inspectors, and clerks to local boards.....	\$995, 955. 55
Salaries, clerks and messenger in the office of the Supervising Inspector General at Washington, D. C.....	23, 003. 79
Total.....	1, 018, 959. 34
Traveling expenses (actual).....	85, 800. 37
Rents, offices.....	36, 069. 60
Furniture, instruments, stationery, supplies, and transportation of same.....	7, 404. 28
Telephone rents and telegrams.....	6, 747. 36
Witness fees and mileage in cases of investigation.....	295. 82
Ice, fuel, and electric light.....	481. 52
Toilet service, laundry, soap, etc.....	277. 70
Janitor, service.....	213. 75
Notarial certifications.....	248. 91
Miscellaneous.....	415. 29
Total traveling and miscellaneous expenses.....	137, 954. 60
Salaries, 1929.....	1, 018, 959. 34
Salaries, 1928.....	914, 832. 73
Increase, 1929.....	104, 126. 61

Contingent expenses, 1929.....	\$137, 954. 60
Contingent expenses, 1928.....	140, 786. 85
Decrease, 1929.....	2, 832. 25
Rents, 1929.....	36, 069. 60
Rents, 1928.....	36, 537. 61
Decrease, 1929.....	468. 01
Traveling expenses, 1929.....	85, 800. 37
Traveling expenses, 1928.....	90, 203. 38
Decrease, 1929.....	4, 403. 01
Total traveling and miscellaneous expenses as noted above.....	137, 954. 60
Total salaries as noted above.....	1, 018, 959. 34
Total expenditures for year ended June 30, 1929.....	1, 156, 913. 94
Total expenditures for year ended June 30, 1928.....	1, 055, 619. 58
Increase, 1929.....	101, 294. 36

The above increase is due to the application of the Welch Act in the payment of the salaries to the employees of the service and to promotions granted to the inspectors.

NUMBER, CLASS, AND TONNAGE OF VESSELS INSPECTED

There is submitted herewith a tabulated statement showing the number, class, and tonnage of vessels regularly inspected by this service and granted certificates:

Certificates of inspection issued to steam and motor vessels and to barges during the year ended June 30, 1929, by districts

Super- vising district	Local district	Domestic vessels										Foreign passenger steam and motor vessels		Total	
		Steam vessels		Motor vessels		Passenger barges		Seagoing barges		Total		Number	Gross tonnage	Number	Gross tonnage
		Number	Gross tonnage	Number	Gross tonnage	Number	Gross tonnage	Number	Gross tonnage	Number	Gross tonnage				
First.....	San Francisco, Calif.....	389	1,230,706	95	65,830	1	100	5	9,502	490	1,306,138	23	137,197	513	1,443,335
	Honolulu, Hawaii.....	17	45,229	6	3,893					23	49,122	14	153,239	37	202,361
	Los Angeles, Calif.....	92	435,860	19	21,149			4	3,480	115	460,489	1	8,600	116	469,089
	Portland, Oreg.....	87	160,849	16	1,179	1	538	1	4,212	105	166,778			105	166,778
Second....	New York, N. Y.....	1,430	2,653,150	129	160,947	2	1,822	111	113,753	1,678	2,929,672	169	2,591,320	1,847	5,520,992
	Albany, N. Y.....	109	39,672	7	1,647					116	41,319	2	188	118	41,507
	New Haven, Conn.....	38	5,562	25	1,429			4	8,114	67	15,045			67	15,045
Third.....	Philadelphia, Pa.....	258	561,303	46	64,692			54	44,463	358	670,458			358	670,458
	Norfolk, Va.....	188	292,201	133	38,042	2	620	81	90,952	404	421,815			404	421,815
	Baltimore, Md.....	249	626,530	111	15,449			8	5,756	368	647,735			368	647,735
	Charleston, S. C.....	35	56,637	35	1,354			2	3,223	72	61,244			72	61,244
	Jacksonville, Fla.....	21	44,408	48	8,052			9	7,400	78	59,860			78	59,860
Fourth....	Savannah, Ga.....	28	49,287	7	5,775			3	3,506	38	58,568			38	58,568
	St. Louis, Mo.....	61	12,134	22	717					83	12,851			83	12,851
	Dubuque, Iowa.....	23	5,191	42	1,373					65	6,564			65	6,564
Fifth.....	Boston, Mass.....	194	393,969	11	18,858			23	24,093	228	436,860	7	27,709	235	464,569
	Bangor, Me.....	5	399	25	873			1	721	31	1,993	2	517	33	2,510
	New London, Conn.....	24	17,269	17	1,198			5	8,158	46	26,565			46	26,565
	Portland, Me.....	33	9,693	14	557			11	8,240	58	18,490			58	18,490
	Providence, R. I.....	44	69,718	9	2,118			5	8,728	58	80,564			58	80,564
Sixth.....	Louisville, Ky.....	28	5,024	9	983					37	6,007			37	6,007
	Evansville, Ind.....	32	8,463	8	494					40	8,957			40	8,957
	Memphis, Tenn.....	50	13,604	9	411	1	698			60	14,713			60	14,713
	Nashville, Tenn.....	45	6,379	7	342					52	6,721			52	6,721
Seventh...	Pittsburgh, Pa.....	67	15,865	10	229	1	263			78	16,357			78	16,357
	Cincinnati, Ohio.....	28	7,985	3	80					31	8,065			31	8,065
	Point Pleasant, W. Va.....	24	2,592	7	154	1	109			32	2,855			32	2,855
Eighth....	Detroit, Mich.....	102	203,826	8	20,813					110	224,639	2	2,622	112	227,261
	Chicago, Ill.....	107	348,886	4	5,273					111	354,159			111	354,159
	Duluth, Minn.....	65	241,401							65	241,401	1	245	66	241,646
	Grand Haven, Mich.....	34	36,875	4	143					38	37,018			38	37,018
	Marquette, Mich.....	28	17,656	1	19					29	17,675	4	1,837	33	19,512
	Milwaukee, Wis.....	73	130,829	16	2,663					89	133,492			89	133,492
	Port Huron, Mich.....	39	111,118	3	808					42	111,926	4	16,350	46	128,276

Ninth	Cleveland, Ohio	131	502,103	5	7,515					136	509,618			136	509,618
	Buffalo, N. Y.	222	653,096			3	340			225	654,036	11	26,427	236	680,463
	Oswego, N. Y.	25	13,954							34	15,460	7	2,006	41	17,466
	Toledo, Ohio	85	289,202	6	509					91	289,711	1	461	92	290,172
Tenth	New Orleans, La.	258	680,983	23	6,530	4	4,489	1	1,152	286	693,154	20	94,911	306	788,065
	Galveston, Tex.	130	487,116	10	22,825	1	945	28	34,222	169	545,108	4	34,015	173	579,123
	Mobile, Ala.	183	482,342	23	909			12	10,899	168	494,150			168	494,150
	San Juan, P. R.	9	17,347	7	136			4	1,188	20	18,671	15	59,129	35	77,800
	Tampa, Fla.	18	19,307	14	908	1	221	5	5,465	38	25,901			38	25,901
Eleventh	Seattle, Wash.	199	413,285	61	31,432			1	979	261	445,696	29	194,693	290	640,389
	Juneau, Alaska	11	749	14	1,263			1	1,809	26	3,821			26	3,821
	St. Michael, Alaska	8	1,728	9	462					17	2,190	4	3,727	21	5,917
	Total, 1929	5,282	11,421,902	1,087	521,569	18	10,145	379	400,015	6,766	12,353,631	320	3,355,193	7,086	15,708,824
Total, 1928	5,302	10,956,705	1,072	421,255	17	10,080	424	452,098	6,815	11,840,138	303	3,546,390	7,118	15,386,528	
Increase (+) or decrease (-)	-20	+465,197	+15	+100,314	+1	+65	-45	-52,083	-49	+513,493	+17	-191,197	-32	+322,296	

Vessels inspected during the year ended June 30, 1929, by geographic divisions

Geographic divisions	Domestic vessels										Foreign passenger steam and motor vessels		Total	
	Steam vessels		Motor vessels		Passenger barges		Seagoing barges		Total		Number	Gross tonnage	Number	Gross tonnage
	Number	Gross tonnage	Number	Gross tonnage	Number	Gross tonnage	Number	Gross tonnage	Number	Gross tonnage				
Pacific coast	803	2,288,406	220	125,208	2	638	12	19,982	1,037	2,434,234	71	497,456	1,108	2,931,690
Atlantic coast	2,671	4,836,965	624	321,157	4	2,442	321	328,295	3,620	5,488,859	195	2,678,863	3,815	8,167,722
Western rivers	358	77,237	117	4,783	3	1,070			478	83,090			478	83,090
Great Lakes	911	2,549,546	56	39,249	3	340			970	2,589,135	30	49,948	1,000	2,639,083
Gulf coast	539	1,669,748	70	31,172	6	5,655	46	51,738	661	1,758,313	24	128,926	685	1,887,239
Total, 1929	5,282	11,421,902	1,087	521,569	18	10,145	379	400,015	6,766	12,353,631	320	3,355,193	7,086	15,708,824
Total, 1928	5,302	10,956,705	1,072	421,255	17	10,080	424	452,098	6,815	11,840,138	303	3,546,390	7,118	15,386,528
Increase (+) or decrease (-)	-20	+465,197	+15	+100,314	+1	+65	-45	-52,083	-49	+513,493	+17	-191,197	-32	+322,296

MISCELLANEOUS INSPECTIONS

Following is a statement of steam vessels granted letters of approval of designs of boilers, engines, and other operating machinery inspected under an act of Congress approved June 9, 1910, which vessels are not inspected annually, only one inspection being made for letter of approval; hulls of United States Government vessels inspected; and boilers in or for United States Government steamers and buildings, and for other United States governmental purposes inspected by inspectors of the Steamboat Inspection Service during the year ended June 30, 1929:

Local inspection district (port)	Steam vessels granted letters of approval		Government vessels inspected	Government boilers inspected
	Number	Gross tonnage		
San Francisco, Calif.			3	69
Honolulu, Hawaii				28
Los Angeles, Calif.			3	55
Portland, Oreg.				54
New York, N. Y.			7	156
Albany, N. Y.				14
New Haven, Conn.				9
Philadelphia, Pa.				65
Norfolk, Va.				79
Baltimore, Md.				134
Charleston, S. C.	1	19	2	50
Jacksonville, Fla.				16
Savannah, Ga.				49
St. Louis, Mo.			2	235
Dubuque, Iowa	1	10		102
Boston, Mass.				42
New London, Conn.				16
Portland, Me.				9
Louisville, Ky.				32
Evansville, Ind.				37
Memphis, Tenn.				36
Nashville, Tenn.	1	76		42
Pittsburgh, Pa.			2	82
Cincinnati, Ohio	1	65	3	66
Point Pleasant, W. Va.			1	59
Detroit, Mich.				11
Chicago, Ill.				25
Duluth, Minn.				12
Grand Haven, Mich.			2	7
Marquette, Mich.	1	36	1	11
Milwaukee, Wis.	1	51	4	31
Cleveland, Ohio	1	180	3	4
Buffalo, N. Y.	2	44	6	5
Oswego, N. Y.				7
Toledo, Ohio				10
New Orleans, La.			28	159
Galveston, Tex.				74
Mobile, Ala.				125
San Juan, P. R.				3
Tampa, Fla.				7
Seattle, Wash.	1	14		36
Total, 1929	10	495	67	2,063
Total, 1928	11	527	63	2,035
Increase (+) or decrease (-)	-1	-32	+4	+28

REINSPECTIONS

Following is a statement of vessel reinspections made by boards of local inspectors during the year ended June 30, 1929:

Local inspection district (port)	Steam vessels	Motor vessels	Barges, etc.	Total	Local inspection district (port)	Steam vessels	Motor vessels	Barges, etc.	Total
San Francisco, Calif.	119	44	-----	163	Detroit, Mich.	100	12	-----	112
Los Angeles, Calif.	14	-----	-----	14	Chicago, Ill.	24	3	-----	27
Portland, Oreg.	4	1	-----	5	Duluth, Minn.	10	-----	-----	10
New York, N. Y.	601	35	4	640	Grand Haven, Mich.	77	4	-----	81
Albany, N. Y.	63	14	-----	77	Marquette, Mich.	27	-----	-----	27
New Haven, Conn.	17	26	-----	43	Milwaukee, Wis.	21	14	-----	35
Philadelphia, Pa.	255	12	-----	267	Port Huron, Mich.	14	-----	-----	14
Norfolk, Va.	58	-----	-----	58	Cleveland, Ohio	15	-----	-----	15
Baltimore, Md.	62	2	-----	64	Buffalo, N. Y.	38	-----	2	40
Charleston, S. C.	10	1	-----	11	Oswego, N. Y.	9	25	-----	34
Jacksonville, Fla.	13	13	-----	26	Toledo, Ohio	14	6	-----	20
Savannah, Ga.	26	9	-----	35	New Orleans, La.	168	27	8	203
St. Louis, Mo.	13	-----	-----	13	Galveston, Tex.	10	4	2	16
Dubuque, Iowa	4	-----	-----	4	Mobile, Ala.	20	10	-----	30
Boston, Mass.	63	-----	-----	63	San Juan, P. R.	13	11	-----	24
Bangor, Me.	21	7	10	38	Tampa, Fla.	6	1	-----	7
New London, Conn.	11	14	-----	25	Seattle, Wash.	67	27	-----	94
Portland, Me.	30	-----	-----	30	Juneau, Alaska	1	-----	-----	1
Providence, R. I.	52	11	-----	63					
Louisville, Ky.	15	-----	-----	15	Total, 1929	2,173	333	27	2,533
Evansville, Ind.	11	-----	-----	11	Total, 1928	2,290	328	20	2,638
Nashville, Tenn.	10	-----	-----	10					
Nashville, Tenn.	8	-----	1	9	Increase (+) or decrease (-)	-117	+5	+7	-105
Pittsburgh, Pa.	8	-----	-----	8					
Cincinnati, Ohio	28	-----	-----	28					
Point Pleasant, W. Va.	23	-----	-----	23					

CARGO VESSELS EXAMINED TO CARRY PERSONS IN ADDITION TO CREW

During the year ended June 30, 1929, 1,125 cargo vessels were examined to carry persons in addition to crew, under the provisions of the act of Congress approved June 5, 1920.

MARINE-BOILER PLATES TESTED

Following is a statement of marine-boiler plates tested at the mills by assistant inspectors of this service during the year ended June 30, 1929, under the act of Congress approved January 22, 1894:

Inspected by assistant inspector at—	Plates rejected because of—								Total			
	Tensile strength	Surface defect	Light gauge	Heavy gauge	Spoiled flanging	Lost	Spoiled at shears	Lamination	Wrong dimension	Rejected	Accepted	Inspected
Coatesville, Pa.	32	37	1	-----	-----	2	-----	-----	-----	72	1,253	1,325
Philadelphia, Pa.	1	2	-----	-----	-----	-----	-----	-----	-----	3	145	148
Pittsburgh, Pa.	3	-----	-----	-----	-----	-----	4	-----	-----	7	618	625
Chicago, Ill.	1	3	-----	-----	-----	-----	2	-----	-----	7	34	41
Do	-----	-----	-----	-----	-----	-----	-----	1	-----	1	51	52
Cleveland, Ohio	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	23	23
Do	3	-----	-----	-----	-----	-----	-----	-----	-----	3	5	8
Do	-----	1	-----	-----	-----	-----	-----	-----	-----	1	120	121
Total, 1929	40	43	1	-----	-----	2	1	6	1	94	2,249	2,343
Total, 1928	79	29	-----	5	3	-----	9	16	-----	141	2,820	2,961
Increase (+) or decrease (-)	-39	+14	+1	-5	-3	+2	-8	-10	+1	-47	-571	-618

STEEL BARS TO BE USED AS STAYS AND BRACES TESTED

Following is a statement of steel bars to be used as boiler stays and braces tested by assistant inspectors detailed for the testing of marine-boiler material at the mills during the year ended June 30, 1929:

Tested by assistant inspector at port of—	Samples tested	Samples rejected	Number of bars accepted	Number of bars rejected
Coatesville, Pa.....	52	1	436	
Pittsburgh, Pa.....	100		649	36
Buffalo, N. Y.....	20		60	8
Chicago, Ill.....	4		10	
Total, 1929.....	176	1	1,155	44

NEW LIFE PRESERVERS INSPECTED

During the year ended June 30, 1929, inspectors of this service inspected new life preservers as follows:

Kind	Inspected	Passed	Rejected
Block cork.....	171,509	169,857	1,652
Balsa block.....	4,570	4,552	18
Kapok.....	38	38	
Total, 1929.....	176,117	174,447	1,670
Total, 1928.....	150,555	149,537	1,018
Increase.....	25,562	24,910	652

INSPECTIONS AT FACTORIES

During the year ended June 30, 1929, the inspectors of this service inspected new apparatus at factories as follows:

Kind	Inspected	Passed	Rejected
New cork-ring life buoys.....	18,570	18,280	290
New lifeboats.....	577	577	
New life rafts.....	299	298	1
New boat davits.....	218	217	1

NUMBER OF PERSONS WHO RECEIVED ONE OR MORE LICENSES

During the year ended June 30, 1929, 20,616 persons received one or more licenses.

OFFICERS LICENSED

Officers licensed of all grades, by local districts, during the year ended June 30, 1929

Local district	Steam and motor vessels				Steam vessels		Motor vessels		Sail vessels of over 700 gross tons		Masters of barges of over 100 gross tons	Total	
	Masters	Mates		First-class pilots	Second-class and special pilots	Chief engineers	Assistant and special engineers	Engineers	Operators	Masters			Chief mates
		Ocean	Inland										
San Francisco, Calif.	366	263	63	10	4	393	342	196	377	48	4	1	2,067
Honolulu, Hawaii	28	16				20	24	15	43				146
Los Angeles, Calif.	122	73	2	1	6	97	109	54	300	19	1		784
Portland, Oreg.	55	25	27	2	4	82	59	29	212	4			499
New York, N. Y.	1,080	453	61	144	11	1,298	826	307	705	59	3	1	4,948
Albany, N. Y.	62		10	28	19	98	8	12	41				278
New Haven, Conn.	25	2	2	14	3	24	3	17	80	3			173
Philadelphia, Pa.	155	130	8	24	12	207	133	78	431	12	1		1,191
Norfolk, Va.	102	24	1	18	14	120	44	33	413	2			771
Baltimore, Md.	180	132	18	14	20	142	108	60	284	10			968
Charleston, S. C.	32	8	2	6	5	40	11	6	102	5			217
Jacksonville, Fla.	44	34	1	11	2	49	48	35	260	3			487
Savannah, Ga.	31	8	5	4		28	33	4	51	1			165
St. Louis, Mo.	38		23	31	3	68	16	12	145				336
Dubuque, Iowa.	6		1	16		18	10	4	70				125
Boston, Mass.	175	209	8	18	4	189	176	37	185	19	2	1	1,023
Bangor, Me.	32	15	9	3	6	22	12	10	122	9			240
New London, Conn.	21	10	2	5	1	40	16	21	142	1			259
Portland, Me.	63	38	2	4	3	61	14	11	140	18			354
Providence, R. I.	42	14	4	4	3	44	15	12	94	4			236
Louisville, Ky.	16		9	15		21	8	6	38				113
Evansville, Ind.	10		3	8	2	27	4		77				131
Memphis, Tenn.	14		2	14	2	33	2		68				135
Nashville, Tenn.	11		5	10		22	3	5	55				111
Pittsburgh, Pa.	34		25	12	1	39	18	2	93				224
Cincinnati, Ohio.	20		11	6		26	6	4	25				98
Point Pleasant, W. Va.	12		10	9	2	21	5	4	67				130
Detroit, Mich.	52	4		14	5	103	50	15	60	1			304
Chicago, Ill.	49	4	1	20	2	73	48	13	89				299
Duluth, Minn.	27			15	6	31	13	1	21				114
Grand Haven, Mich.	20			9	5	38	29	1	63				165
Marquette, Mich.	11			6	3	22	3	2	60				107
Milwaukee, Wis.	54	1		56	8	71	56	18	53				317
Port Huron, Mich.	44			18	2	64	42	1	35				206

Officers licensed of all grades, by local districts, during the year ended June 30, 1929—Continued

Local district	Steam and motor vessels				Steam vessels		Motor vessels		Sail vessels of over 700 gross tons		Masters of barges of over 100 gross tons	Total	
	Masters	Mates		First-class pilots	Second-class and special pilots	Chief engineers	Assistant and special engineers	Engineers	Operators	Masters			Chief mates
		Ocean	Inland										
Cleveland, Ohio.....	53	1		61	2	121	95	22	76			431	
Buffalo, N. Y.....	53	6		39	13	136	47	15	84		1	394	
Oswego, N. Y.....	17			7	5	23	12		118			182	
Toledo, Ohio.....	18	1		17	1	35	12	5	77			167	
New Orleans, La.....	234	102	22	32	32	240	211	81	144	15	1	1,114	
Galveston, Tex.....	103	67	2	6	12	73	55	25	187	7	2	539	
Mobile, Ala.....	70	29	6	30	7	88	43	20	112	10		415	
San Juan, P. R.....	9	2		2	2	6	5	7	60	2		95	
Tampa, Fla.....	43	14		3	2	35	33	37	206	1	1	375	
Seattle, Wash.....	166	100	50		13	140	115	63	205	21	2	875	
Juneau, Alaska.....	16	9	3		8	17	5	16	109	1		184	
St. Michael, Alaska.....	12	1	1	1	5	7	1	3	44			75	
Total, 1929.....	3,827	1,795	399	767	260	4,553	2,928	1,319	6,423	275	14	7	22,567
Total, 1928.....	4,479	1,625	385	823	334	6,044	2,458	1,383	6,877	350	11	4	24,773
Increase (+) or decrease (-).....	-652	+170	+14	-56	-74	-1,491	+470	-64	-454	-75	+3	+3	-2,206

CERTIFICATES OF SERVICE ISSUED TO ABLE SEAMEN

There is submitted herewith a tabulated statement showing the number of applications received for certificates of service as able seamen, the number of applications rejected, and the number of certificates issued during the year ended June 30, 1929:

Local inspection district	Applications received	Applications rejected	Certificates issued	Local inspection district	Applications received	Applications rejected	Certificates issued
San Francisco, Calif.	751	46	705	Grand Haven, Mich.	35	8	27
Honolulu, Hawaii	105	8	97	Marquette, Mich.	10	1	9
Los Angeles, Calif.	184	2	182	Milwaukee, Wis.	144	7	137
Portland, Oreg.	75	20	55	Port Huron, Mich.	27	3	24
New York, N. Y.	2,261	87	2,174	Cleveland, Ohio	385	67	318
New Haven, Conn.	3		3	Buffalo, N. Y.	262	33	229
Philadelphia, Pa.	352	13	339	Oswego, N. Y.	4		4
Norfolk, Va.	191	16	175	Toledo, Ohio	108		108
Baltimore, Md.	697	80	617	New Orleans, La.	547	14	533
Charleston, S. C.	43	4	39	Galveston, Tex.	164	3	161
Jacksonville, Fla.	147	11	136	Mobile, Ala.	252	21	231
Savannah, Ga.	79	12	67	San Juan, P. R.	9		9
St. Louis, Mo.	1		1	Tampa, Fla.	75	3	72
Boston, Mass.	317	36	281	Seattle, Wash.	306	14	292
Bangor, Me.	32		32	Juneau, Alaska	5		5
New London, Conn.	6		6	Total, 1929	8,211	579	7,632
Portland, Me.	62	1	61	Total, 1928	8,466	522	7,944
Providence, R. I.	88	10	78	Increase (+) or decrease (-)	-255	-57	-312
Detroit, Mich.	194	44	150				
Chicago, Ill.	207	15	192				
Duluth, Minn.	83		83				

CERTIFICATES OF EFFICIENCY ISSUED TO LIFEBOAT MEN

The following statement shows the number of applications received for certificates of efficiency as lifeboat man, the number of applicants rejected, and the number of certificates issued during the year ended June 30, 1929:

By whom issued	Applications received	Applications rejected	Certificates issued	By whom issued	Applications received	Applications rejected	Certificates issued
Local inspectors of vessels:				Local inspectors of vessels—Continued.			
San Francisco, Calif.	108		108	San Juan, P. R.	2		2
Los Angeles, Calif.	64		64	Tampa, Fla.	65		65
Portland, Oreg.	9	3	6	Seattle, Wash.	4,080	2,475	1,605
New York, N. Y.	199		199	St. Michael, Alaska	9		9
Albany, N. Y.	9		9	Juneau, Alaska	213		213
New Haven, Conn.	5		5	Total by local inspectors	6,296	2,539	3,757
Philadelphia, Pa.	22		22	Coast and Geodetic Survey, Department of Commerce	315	2	313
Norfolk, Va.	23		23	Bureau of Lighthouses, Department of Commerce	543	94	449
Baltimore, Md.	284		284	U. S. Coast Guard, Treasury Department	4,271	1,245	3,026
Jacksonville, Fla.	361	1	360	Navy Department:			
Savannah, Ga.	107	10	97	Navy Yards—			
Boston, Mass.	82		82	New York, N. Y.	159	80	79
Bangor, Me.	42		42	Portsmouth, Va.	74		74
New London, Conn.	45		45	Receiving barracks at Philadelphia, Pa.	127		127
Portland, Me.	5		5	Total, 1929	11,785	3,960	7,825
Providence, R. I.	109		109	Total, 1928	11,049	4,328	6,721
Detroit, Mich.	194		194	Increase (+) or decrease (-)	+736	-368	+1,104
Chicago, Ill.	2		2				
Duluth, Minn.	6		6				
Grand Haven, Mich.	34		34				
Milwaukee, Wis.	2		2				
Port Huron, Mich.	2		2				
Cleveland, Ohio	72	50	22				
Buffalo, N. Y.	12		12				
Toledo, Ohio	19		19				
New Orleans, La.	50		50				
Galveston, Tex.	14		14				
Mobile, Ala.	46		46				

LIVES LOST ON VESSELS SUBJECT TO INSPECTION

The statement following shows the loss of life on vessels subject to inspection during the year ended June 30, 1929, divided as to passengers and crew, passenger and nonpassenger steamers, by supervising inspection districts, and by causes:

Cause	First		Second		Third		Fourth		Fifth		Sixth	
	Passengers	Crew	Passengers	Crew	Passengers	Crew	Passengers	Crew	Passengers	Crew	Passengers	Crew
Fire:												
Passenger steamers.....			2						1			
Nonpassenger steamers.....					1							
Collision:												
Passenger steamers.....		2										
Nonpassenger steamers.....		1	3		3							
Wrecked: Nonpassenger steamers.....		1										
Grounding: Nonpassenger steamers.....			1									
Explosion, escape of steam, etc.: Nonpassenger steamers.....				3	5					1		
Foundered in storm: Nonpassenger steamers.....									21			
Sinking: Nonpassenger steamers.....				2	2							
Accidental drowning:												
Passenger steamers.....		2	6	5	1	1	4	1				
Nonpassenger steamers.....		10	21		5		1		4			3
Suicide:												
Passenger steamers.....	6	1	12		3		1	1			1	
Nonpassenger steamers.....		2	2									
Miscellaneous:												
Passenger steamers.....	13	7	11	5	1		1	1				
Nonpassenger steamers.....		10	13	16	17	5	1		21			1
Total:												
Passenger steamers.....	19	12	19	12	5	1	5	3	2		1	
Nonpassenger steamers.....		24	3	48	7	21		2		47		4
Grand total.....	19	36	22	60	12	22	5	5	2	47	1	4
Last year.....	10	45	13	50	3	16		1	2	17	3	5
Increase (+) or decrease (-).....	+9	-9	+	+10	+9	+6	+5	+4		+30	-2	-1

Cause	Seventh		Eighth		Ninth		Tenth		Eleventh		Total	
	Passengers	Crew	Passengers	Crew	Passengers	Crew	Passengers	Crew	Passengers	Crew	Passengers	Crew
Fire:												
Passenger steamers.....					1						2	2
Nonpassenger steamers.....						1			1			3
Collision:												
Passenger steamers.....												2
Nonpassenger steamers.....												7
Wrecked: Nonpassenger steamers.....												1
Grounding: Nonpassenger steamers.....												1
Explosion, escape of steam, etc.: Nonpassenger steamers.....						2		6		1		18
Foundered in storm: Nonpassenger steamers.....				1				2				24
Sinking: Nonpassenger steamers.....									1			5
Accidental drowning:												
Passenger steamers.....	3	1	2	2			3	1			19	13
Nonpassenger steamers.....		6		13		8		8				79
Suicide:												
Passenger steamers.....		1			1		3				27	3
Nonpassenger steamers.....												4
Miscellaneous:												
Passenger steamers.....			3	1			2	1	7		28	15
Nonpassenger steamers.....			3	7		4		10			10	78
Total:												
Passenger steamers.....	3	2	5	3	2		8	2	7		76	35
Nonpassenger steamers.....		9		21		15		26		3	10	220
Grand total.....	3	11	5	24	2	15	8	28	7	3	86	255
Last year.....	4	7	29	10	1	8	14	29	2	6	81	194
Increase (+) or decrease (-).....	-1	+4	-24	+14	+1	+7	-6	-1	+5	-3	+5	+61

¹ Stowaways.

The total number of lives lost from all causes, passengers and crew, was 341, an increase of 66 over the previous year. Of the lives lost, 272 were from suicide, accidental drowning, and other causes beyond the power of the service to prevent, leaving a loss of 69 fairly chargeable to accidents, collisions, foundering, etc.

LIVES SAVED

During the year the number of lives directly saved by means of the life-saving appliances required by law was 741.

ACCIDENTS RESULTING IN LOSS OF LIFE

The total number of accidents resulting in loss of life during the past year was 260, an increase of 28 over the previous year. Enumerated by supervising inspection districts, accidents occurred as follows: First, 48; second, 73; third, 21; fourth, 9; fifth, 14; sixth, 5; seventh, 10; eighth, 28; ninth, 16; tenth, 31; eleventh, 5.

The following disasters resulted in an unusually large loss of life:

On July 31, 1928, about 6 a. m., while the wrecking and towing steamer *Chancellor*, of 383 gross tons, was lying at the repair yard of the Merritt, Chapman & Scott Corporation, at Clifton, Staten Island, N. Y., her boiler exploded. Three men, the chief engineer and two firemen, lost their lives. The case was investigated by the local inspectors at New York, N. Y., and dismissed.

On August 9, 1928, while the steamer *William A. McKenney* was on a voyage from San Pedro, Calif., to Boston, Mass., in approximately latitude $21^{\circ} 28' N.$, longitude $108^{\circ} 21' W.$, a terrific cyclone was encountered, and, while the tarpaulin on No. 3 hatch was being replaced, 14 men were washed overboard and drowned. The case was investigated by the local inspectors at Boston, Mass., and as no licensed officer was deemed at fault the case was dismissed.

On August 29, 1928, the towing steamer *Aliquippa*, while tied to an empty steel barge at the Jones & Laughlin landing at Aliquippa, Pa., capsized and sank, resulting in the loss of three lives. As a result of the investigation of this case by the local inspectors at Pittsburgh, Pa., charges were preferred against Norman D. Jones, master and pilot, for violation of section 4439, Revised Statutes; Paul Leezer, mate, for violation of section 4440; and Lawrence Simms, engineer, for violation of section 4441; for negligence and inattention to duty. The licenses of Norman D. Jones and Paul Leezer were suspended for one year, and the license of Lawrence Simms was suspended for 90 days.

On September 12, 1928, while the pump man on the tanker *Shreveport* was investigating a leak in the main suction pipe from No. 4 tank and preparing to steam the tank out, an explosion occurred which resulted in the death of five men. The vessel after catching on fire was abandoned by the crew, who were later picked up by other vessels. The *Shreveport* was later taken in tow by the *Mariners Harbor* and after the crew of that vessel had extinguished the fire on the *Shreveport* a crew was put aboard who brought the vessel into Charleston Harbor. The case was investigated by the local inspectors at Charleston, S. C., and, as no blame could be attached to any licensed officer, the case was dismissed.

On December 8, 1928, while the tank steamer *Gulfland* was lying at the refining company's dock at Port Arthur, Tex., taking on cargo of gasoline, etc., an explosion occurred in pump room of vessel, causing the death of three men. The case was investigated by the local inspectors at Galveston, Tex.

On January 10, 1929, the steam trawler *Seiner* left New York, N. Y., for the fishing grounds off Georges Banks, with a crew of 21, and was last heard from on January 13, 1929. On January 30 the steamer *Brant* dragged up the lifeboat belonging to the *Seiner*. The local inspectors at New London investigated the case and concluded that the *Seiner* had foundered from some unknown cause with the loss of the entire crew.

PASSENGERS CARRIED

During the fiscal year 328,465,552 passengers were carried on steam vessels that are required by law to report the number of passengers carried. Dividing this number by 86, the total number of passengers lost, shows that 3,819,366 were carried for each passenger lost. In connection with the prevention of overloading of vessels, 2,993,694 passengers were counted during the year by representatives of this service.

EXAMINATIONS FOR COLOR BLINDNESS

During the year ended June 30, 1929, 6,931 applicants for original licenses and for renewals of licenses were examined for visual defects, 32 of whom were found color blind, or had other visual defects, and were rejected, and 6,899 were passed. As compared with the previous year, these figures show a decrease of 490 in the number examined and 500 in the number passed.

WORK PERFORMED BY INSPECTORS IN CENTRAL OFFICE

The following statement embraces work performed by the inspectors in the central office during the fiscal year ended June 30, 1929:

Vessels inclined.....	41
Offsets taken and calculations made.....	29
Reinspections of vessels.....	69

MISCELLANEOUS REPORTS

The following statement embraces various matters and occurrences relating to the work of the Steamboat Inspection Service for the year ended June 30, 1929:

VESSELS

Vessels from which certificates of inspection were withdrawn.....	8
Vessels refused certificates of inspection:	
Domestic steam vessels.....	53
Domestic vessels propelled by gas, fluid, naphtha, or electric motors.....	11
Domestic vessels and barges of over 100 gross tons carrying passengers for hire, other than steam, motor, and sail vessels.....	1
Domestic seagoing barges of 100 gross tons or over.....	2
Foreign steam vessels.....	2
Total.....	<u>77</u>

BOILERS

Boilers inspected:	
Steel (riveted plates)-----	10, 635
Iron (riveted plates)-----	70
Pipe-----	2, 255
Total-----	<u>12, 960</u>
Boilers found defective:	
Gave way under hydrostatic pressure—	
Steel (riveted plates)-----	318
Iron (riveted plates)-----	1
Pipe-----	4
Total-----	<u>423</u>
Defective from other causes—	
Steel (riveted plates)-----	1, 901
Iron (riveted plates)-----	7
Pipe-----	152
Total-----	<u>2, 060</u>
Boilers condemned from further use:	
Steel (riveted plates)-----	34
Pipe-----	1
Total-----	<u>35</u>
Defects in boilers and attachments:	
Sheets-----	1, 470
Heads-----	368
Steam and mud drums-----	1, 250
Flues and tubes-----	76, 098
Steam pipes-----	685
Stay bolts-----	29, 918
Braces-----	890
Other parts-----	6, 846
Total-----	<u>117, 525</u>
Tests of samples of steel and iron plates to be used in marine boilers, other than material tested at the mills by assistant inspectors:	
Samples tested-----	6
Tests of samples of steel bars to be used as stays and braces: Samples tested-----	
	<u>131</u>

OFFICERS

Licenses suspended-----	210
Licenses revoked-----	18
Licenses refused-----	126
Licenses canceled-----	15
Violations of the law:	
Cases investigated-----	1, 344
Cases dismissed-----	1, 023
Cases reported to district attorneys and chief officers of customs-----	228
Number of appeals from decisions of local boards-----	27
Decisions of local boards revoked by supervising inspectors-----	4
Decisions of local boards modified by supervising inspectors-----	12
Decisions of local boards sustained by supervising inspectors-----	11

VESSELS LOST

Vessels under the jurisdiction of the Steamboat Inspection Service
wrecked or foundered:

Steam vessels.....	48
Motor vessels.....	15
Sail vessels.....	6
Barges, etc.....	19
Total.....	88

PROPERTY LOST

Amount of property lost:

By explosion or accidental escape of steam.....	\$221, 134
By wreck or founder.....	4, 029, 001
By collision between vessels.....	3, 827, 721
By fire.....	1, 192, 500
By snags.....	84, 122
From miscellaneous causes.....	4, 019, 806
Total.....	13, 374, 284

Very truly yours,

DICKERSON N. HOOVER,
Supervising Inspector General.

PATENT OFFICE

DEPARTMENT OF COMMERCE,
UNITED STATES PATENT OFFICE,
Washington, July 1, 1929.

The honorable the SECRETARY OF COMMERCE.

DEAR MR. SECRETARY: I have the honor to submit the following report of the business of the Patent Office for the year ended June 30, 1929:

The last fiscal year has been an extremely busy one in the Patent Office. The work laid before it by the inventors of the country continues in enormous volume. That the office has made extraordinary efforts to handle this great volume of work may be seen from the fact that the output of the office—the total number of patents, design patents, trade-marks, etc., that were issued—increased from 61,134 in 1928 to 64,245, an increase of 3,111. It is a noteworthy fact that more patents have been granted during the last 10 years than during the 100 years from President Washington's inauguration in 1789 until President Harrison's inauguration in 1889. The number of applications awaiting official action has decreased during the year from 106,575 to 103,236, or 3,339. The increase in the output has resulted from an increase in the personnel. However, owing to the lack of training of the new personnel, the increase of force was not effective during the first six months and, in consequence, on December 30, 1928, the number of applications awaiting official action had reached 111,854. During the second half of the year the effectiveness of the additional force has been quite evident, and the number of applications awaiting official action during this latter six months was actually reduced by 8,618. This reduction in arrears is very gratifying to the officials of the Patent Office, but however commendable it may be, the number of cases now awaiting action (103,236) is so great that at this rate of gain it would take from five to six years to make the work practically current, or so that an applicant who is paying the fees for performing the work may obtain an official action with reasonable promptness. The fees received by the office again broke all records, the receipts for 1929 totaling \$3,783,481.65, an increase of \$78,143.34 over those for the previous year, which was itself a peak year in this respect. However, owing to the increased salaries provided by the Welch Act, and also to the increase of employees, the total expenditures amounted to \$4,391,860.16, creating a deficit for the year of \$608,378.51. After deducting the deficit, the net surplus to date in the United States Treasury to the credit of the Patent Office now amounts to \$6,339,588.64.

In reducing the number of cases awaiting official action during the last six months by over 8,000 applications, it was necessary for the

force of examiners to make an official action in over 1,000 cases each working day, or at the rate of over two applications per day for each assistant examiner. To act upon this enormous number of cases each day, the force must be pushed to its full capacity consistent with the proper quality of the work. In view of the foregoing, it is manifest that there must be a further increase in the personnel of the office in order that an inventor may receive action within a reasonably prompt time. I therefore urge an increase in the force of 100 examiners. If the Patent Office is given such an increase and the work remains fairly constant, it will be possible in about one and a half years from the time this increased force is actually at work to bring the work so nearly to date that an applicant may receive an action within two months. This does not mean from the time the appropriation is made, for it would take, probably, six months for the Civil Service Commission to furnish a force of 100 examiners. I can not too strongly urge this increase in force.

Our board of appeals must also have relief. Five years ago the appeals taken to this board amounted to 978 ex parte and 229 interference appeals, a total of 1,207. Last year the number of appeals amounted to 2,262 ex parte cases and 387 interference cases, or a total of 2,649. Thus the work has more than doubled within five years. It is obvious that this tremendous number of appeals can not be handled by our present board. Furthermore, as the output of the Patent Office increases, especially in catching up present arrearages, the number of appeals is likely to correspondingly increase. I therefore recommend that the board of appeals be increased by at least one additional examiner in chief and one additional assistant commissioner who would devote nearly all of his time to the work of the board of appeals. As it is now, an applicant is compelled to wait a year to have his appeal heard. This is frequently fatal to the financial interest of the applicant and is decidedly against public policy.

These increases in the personnel are absolutely essential if the Patent Office is to function as it should.

Resignations still continue in too large a number for the safety of the office. From January 1 to June 30 the office lost 42 experienced examiners; 20 resignations were received during the months of May and June. It requires for a long period two or more new examiners, together with a large amount of time of an experienced examiner in close supervision, to handle the work that was done by one of these trained examiners who has resigned. The net loss due to the resignation of a well-trained examiner is very great. As a measure looking to relief, it is suggested that since professional grades 4 and 6 are vacant so far as this office is concerned, the principal examiners be allocated in grade 6 and associate examiners in grade 4. Larger salaries will surely induce some examiners to remain in the service. Furthermore, I am firmly of the opinion that the classification definitions should be changed so that after an assistant examiner has given two years of satisfactory service, he should be transferred to professional grade 2, and at the end of three years of satisfactory service to professional grade 3. If the classification definitions were thus changed, young examiners would know that they would receive a certain salary after a certain definite period of experience, provided the quality and quantity of work done were satisfactory. Certainly something should be done to decrease the resignations.

Except for the work of the examining corps, the work of the Patent Office is in excellent shape. All trade-mark applications are acted upon within one month of filing and amended cases within two weeks. This is also true of all design patent applications. The work of the clerical organization, consisting of about 600 employees (with the exception of two divisions which do not delay the work of the office), is practically up to date. The patents and trade-marks—about 1,200 each week—and the Official Gazette are issued each Tuesday with clocklike precision.

The copy-sales division has also broken all records. The number of printed copies of patents sold last year increased from 3,528,000 to 3,797,000, and the total number of copies disposed of (including those sent to public libraries and foreign countries) increased from 5,949,306 to 6,405,781. In fact, the number of copies of patents disposed of by this office has increased in the last eight years from 3,653,040 to 6,405,781, an increase of 2,752,741, or 75 per cent. The additional copies sold this year over eight years ago brought in an increased revenue of \$163,515 for the year. This branch of the service should certainly be treated liberally, as it more than pays for itself, and the business is conducted so efficiently that our copy-sales force takes pride in the fact that the office is selling the increased number of copies with substantially the same sales force it had eight years ago. However, the force must now be enlarged in order to permit the increase of business to be properly cared for and not permit the furnishing of copies to be delayed.

The work of the photostat division has also largely increased, the number of photostats furnished last year amounting to 713,512, an increase of 96,000 over the previous year. Since 1921, the number of photostats made increased from 190,000 to over 700,000. This is also a profit-making division of the office and should be so well supplied that photostat copies can be furnished to the public without delay. The unique feature of the copy-sales division and the photostat division is that the more money used in these divisions the more profit we turn back into the Treasury.

In closing my report, I wish once more to emphasize the necessity of additional personnel and, of course, additional room to house the additional personnel.

Following is an appendix giving the usual statistical report.

APPENDIX

STATISTICS

Applications received during the fiscal year ended June 30, 1929¹

With fees:	
Applications for patents for inventions.....	87, 039
Applications for patents for designs.....	4, 548
Applications for reissues of patents.....	442
	92, 029
Applications for registration of trade-marks.....	² 19, 512
Applications for registration of labels.....	1, 964
Applications for registration of prints.....	991
	22, 467
Total, with fees.....	114, 496
Without fees: Applications for inventions (act Mar. 3, 1883).....	192
Grand total.....	114, 688

Applications for patents for inventions with fees

Year ended June 30—	Year ended June 30—
1920..... 81, 948	1925..... 77, 926
1921..... 84, 248	1926..... 80, 682
1922..... 88, 243	1927..... 84, 511
1923..... 77, 645	1928..... 88, 482
1924..... 76, 024	1929..... 87, 039

Applications for patents, including reissues, designs, trade-marks, labels, and prints with fees

Year ended June 30—	Year ended June 30—
1920..... 102, 940	1925..... 103, 591
1921..... 107, 656	1926..... 110, 030
1922..... 113, 597	1927..... 113, 783
1923..... 100, 724	1928..... 116, 844
1924..... 99, 574	1929..... 114, 496

Patent applications awaiting action

June 30—	June 30—
1920..... 34, 355	1925..... 44, 556
1921..... 49, 334	1926..... 43, 765
1922..... 67, 367	1927..... 64, 646
1923..... 72, 475	1928..... 106, 575
1924..... 60, 334	1929..... 103, 236

Patents withheld and patents expired

	1928	1929
Letters patent withheld for nonpayment of final fees.....	8, 915	8, 565
Applications allowed awaiting payment of final fees.....	18, 726	19, 576
Patents expired.....	33, 573	34, 254
Applications in which issue of patent has been deferred under sec. 4885 R. S.....	274	168
Applications in process of issue.....	3, 311	3, 323

¹ Including applications in which fees were refunded and transferred.

² Includes 1,953 applications for the renewal of trade-mark registration.

Patents granted and trade-marks, labels, and prints registered

	1925	1926	1927	1928	1929
Letters patent.....	45,218	46,464	43,244	41,067	43,617
Design patents.....	2,692	2,763	2,478	2,698	3,201
Reissue patents.....	237	268	293	349	329
Trade-marks.....	14,542	14,236	14,858	14,219	14,391
Labels.....	1,400	1,676	1,782	1,857	1,774
Prints.....	615	868	1,074	944	933
Total.....	64,704	66,275	63,729	61,134	64,245

Statement of receipts and earnings for the fiscal year ended June 30, 1929

Unearned balance at close of business June 30, 1928.....		\$150,642.59
Receipts for fiscal year ended June 30, 1929.....	\$3,731,644.70	
Receipts from sale of Official Gazette and other publications through Government Printing Office.....	51,836.95	
Total receipts.....		3,783,481.65
		3,934,124.24
Earnings:		
Inventions, first fees.....	\$1,736,635.00	
Extra claims.....	44,292.00	
Reissues.....	13,260.00	
Designs.....	51,415.00	
Design extensions.....	21,015.00	
Trade-marks.....	193,550.00	
Labels and prints.....	16,248.00	
Total.....		2,076,415.00
Final fees.....	871,640.00	
Extra claims.....	24,419.00	
Total.....		896,059.00
Appeals.....	42,915.00	
Oppositions.....	8,070.00	
Disclaimers.....	600.00	
Total.....		51,585.00
Printed copies, etc.....	379,705.35	
Photoprints.....	12,392.30	
Photostats.....	57,595.10	
Manuscript.....	86,603.60	
Certified printed copies, etc.....	9,221.80	
Recording articles of incorporation.....	666.00	
Recording International trade-marks.....	45.00	
Registration of attorneys.....	720.00	
Total.....		546,859.15
Drawings.....		23,633.34
Assignments.....		98,908.35
Total.....		3,693,459.84
Receipts from sale of Official Gazette, etc.....	51,836.95	
Total.....		3,745,296.79
Refunded.....		29,113.24
Unearned balance June 30, 1929.....		159,714.21
		3,934,124.42

Expenditures, fiscal year ended June 30, 1929

Salaries.....		\$2, 987, 007. 13
Scientific Library.....		7, 951. 40
Investigating public use.....		688. 25
Photolithographing:		
Current issue.....	\$69, 970. 33	
Reproduction.....	132, 242. 19	
Photographic printing.....	19, 281. 23	
Photostat supplies.....	38, 213. 95	
Dry mounts.....	4, 045. 19	
Total.....		263, 752. 89
Printing and binding:		
Specifications.....	797, 420. 11	
Official Gazette.....	175, 345. 97	
Indexes.....	9, 446. 41	
Total.....		982, 212. 49
Miscellaneous.....		60, 000. 00
Furniture and filing cases.....		62, 248. 00
Contingent expenses, including telephones, stationery, postage on foreign mail, etc.....		28, 000. 00
Total.....		4, 391, 860. 16

Receipts and expenditures

Total receipts from all sources.....	\$3, 783, 481. 65
Expenditures.....	4, 391, 860. 16
Deficit.....	608, 378. 51
Total net surplus to date.....	6, 339, 588. 64

Comparative statement

June 30—	Receipts	Expenditures	Surplus
1920.....	\$2, 615, 697. 33	¹ \$2, 436, 561. 37	\$179, 135. 96
1921.....	2, 712, 119. 69	¹ 2, 610, 373. 96	71, 745. 73
1922.....	2, 894, 286. 58	¹ 2, 722, 205. 37	172, 081. 21
1923.....	3, 026, 486. 36	¹ 3, 112, 022. 07	-85, 535. 71
1924.....	3, 042, 276. 22	¹ 3, 273, 341. 37	-231, 065. 15
1925.....	3, 271, 253. 89	3, 775, 476. 97	-504, 223. 08
1926.....	3, 457, 774. 53	3, 857, 952. 11	-400, 177. 58
1927.....	3, 524, 155. 55	3, 769, 604. 03	-245, 448. 48
1928.....	3, 705, 338. 31	3, 839, 771. 66	-134, 433. 35
1929.....	3, 783, 481. 65	4, 391, 860. 16	-608, 378. 51

¹ Including increase in compensation (bonus).*Litigated cases*

Oppositions instituted.....	782
Cancellations instituted.....	161
Interferences declared (including 243 trade-mark).....	1, 746
Interferences heard (including 357 trade-mark).....	616
Interferences disposed of before final hearing (including 853 trade-mark).....	2, 047
Interferences disposed of after final hearing (including 364 trade-mark).....	624
Interferences awaiting decision (including 15 trade-mark).....	45

Oldest case awaiting action, March 7, 1929.

To board of appeals:	
Appeals in interference cases.....	387
Ex parte appeals.....	2, 262
	<u>2, 649</u>
Appeals in interference cases disposed of.....	309
Ex parte appeals disposed of.....	1, 657
	<u>1, 966</u>
Interference cases awaiting action.....	349
Ex parte cases awaiting action.....	2, 726
	<u>3, 075</u>

Oldest interference case awaiting action, December 7, 1928.

Oldest ex parte case awaiting action, December 5, 1928.

To the commissioner:	
Appeals in trade-mark interferences.....	11
Appeals in opposition cases.....	89
Appeals in cancellation cases.....	26
Appeals in ex parte trade-mark cases.....	51
Interlocutory appeals.....	31
Total.....	208
Petitions ex parte.....	5, 743
Petitions inter partes.....	181
	<u>5, 924</u>
Total.....	<u>6, 132</u>

Cases disposed of by commissioner:	
Appeals in trade-mark interferences.....	9
Appeals in trade-mark oppositions.....	78
Appeals in trade-mark cancellations.....	24
Interlocutory appeals.....	30
Ex parte appeals in trade-mark cases.....	51
Total.....	192
Petitions.....	5, 162
Total.....	<u>5, 354</u>

To Court of Customs and Patent Appeals of the District of Columbia:	
Appeals in ex parte cases (including 8 trade-mark).....	140
Appeals in interference cases (including 3 trade-mark).....	44
Appeals in trade-mark oppositions.....	35
Appeals in trade-mark cancellations.....	10
Total.....	<u>229</u>

OTHER DETAILS OF BUSINESS FOR THE FISCAL YEAR

As to the volume of business, the office received during the year 92,029 applications for patents, reissues, and designs; 17,559 trade-mark applications and 1,953 applications for renewal of trade-mark registrations; and 1,964 label and 991 print applications; 205,991 amendments to patent applications, 9,188 amendments to design applications, and 24,687 amendments to trade-mark, label, and print applications.

The number of letters constituting the miscellaneous correspondence received and indexed was 404,624. In addition 52,702 letters were returned with information.

The number of printed copies of patents sold was 3,731,218; 1,370,718 copies of patents were shipped to foreign governments and 697,118 copies furnished public libraries. The total number of copies of patents furnished was 6,405,781, including those for office use and other departments.

The office received for record 52,554 deeds of assignment.

The drafting division made 757 drawings for inventors, and corrected 18,697 drawings on request of inventors; 156,619 sheets of drawings were inspected, and 18,765 letters answered.

Typewritten copies of 11,725,100 words were furnished at 10 cents per 100 words. The office certified to 13,722 manuscript copies and furnished 10,747 miscellaneous certified copies. The office also furnished 314,237 photostat copies of manuscript pages, 67,997 photographic copies, and 351,710 photostat copies of publications and foreign patents, for sale; 4,672 photostat-manuscript pages, 106 certified manuscript copies, and 4,973 photostat copies for Government departments, without charge; 28,112 photostat and 15,236 photographic copies for use of the Patent Office; 14,480 photostat copies for photoprint section, Patent Office; in all, 713,512 photostat and 83,233 photographic copies.

Very truly yours,

THOMAS E. ROBERTSON,
Commissioner of Patents.

BUREAU OF MINES

DEPARTMENT OF COMMERCE,
BUREAU OF MINES,
Washington, July 1, 1929.

The honorable the SECRETARY OF COMMERCE.

DEAR MR. SECRETARY: In response to your request I furnish the following condensed report on the work of the Bureau of Mines during the fiscal year ended June 30, 1929:

FINANCES

The total allotment of funds made to the Bureau of Mines for the fiscal year ended June 30, 1929, was \$3,733,094.67. Of this amount, \$3,606,494.45 was spent, leaving an unexpended balance of \$126,600.22, due mainly to uncompleted work in the helium program, resulting in the carrying over of \$121,000 of helium-plant funds as authorized expenditures for the fiscal year 1929-30.

On the regular work of the bureau \$2,286,705.35 was expended directly, this figure being subject to slight corrections due to unpaid obligations. In addition, for the helium program, which is purely service work for the Army and Navy and has no part in the regular work of the bureau, \$1,259,876.67 was appropriated direct to the bureau, and \$180,000 was transferred from the Army and Navy for the purchase, at cost, of helium produced by the bureau for these military-service branches.

There is given in Table 2 a complete statement of the distribution of congressional appropriations to branches and divisions within the bureau, and the expenditure of these funds in 1929 by the various divisions of the bureau. Table 1 presents classified and complete information regarding the financial history of the bureau since its organization in 1910.

TABLE 1.—Bureau of Mines appropriations and expenditures, fiscal years ended June 30, 1911-1929

Fiscal year	Appropriated to the Bureau of Mines	Departmental allotments ¹	Funds transferred from other departments	Total funds available for expenditure	Unexpended balance	Total expenditures	Expenditures exclusive of service items ²
1911.....	\$502,200.00	\$34,200.00	.....	\$536,400.00	\$22,818.27	\$513,581.73	\$513,581.73
1912.....	475,500.00	45,640.00	.....	521,140.00	6,239.77	514,900.23	514,900.23
1913.....	583,100.00	47,850.00	.....	630,950.00	4,087.20	626,862.80	626,862.80
1914.....	664,000.00	57,307.79	.....	721,307.79	4,678.29	716,629.50	716,629.50
1915.....	730,500.00	55,424.60	.....	785,924.60	4,178.11	781,746.49	781,746.49
1916.....	757,300.00	48,710.87	.....	806,010.87	9,058.63	796,952.24	796,952.24
1917.....	981,050.00	52,400.00	.....	1,033,450.00	48,588.10	984,871.90	984,871.90
1918.....	1,467,070.00	51,901.98	\$8,062,000.00	4,580,971.98	395,745.10	4,185,226.88	1,172,939.64
1919.....	3,245,285.00	49,542.86	\$8,600,000.00	11,894,827.86	2,452,236.78	9,442,591.08	1,137,471.37
1920.....	1,216,897.00	52,800.00	.....	1,269,697.00	9,592.18	1,260,104.82	1,245,891.36
1921.....	1,362,642.00	62,618.72	666,720.00	2,091,980.72	13,985.89	2,077,994.83	1,412,923.15
1922.....	1,474,300.00	59,800.00	182,200.00	1,716,300.00	52,120.45	1,664,179.55	1,483,038.47
1923.....	1,580,900.00	70,814.30	97,100.00	1,748,814.30	10,959.08	1,737,855.22	1,640,840.57
1924.....	1,784,959.00	50,710.00	347,820.00	2,183,489.00	38,085.43	2,145,403.57	1,804,800.41
1925.....	2,028,298.00	57,500.00	236,465.86	2,322,263.86	107,743.20	2,214,520.66	1,998,669.20
1926.....	1,875,010.00	81,220.00	510,501.15	2,466,731.15	28,891.78	2,437,839.37	1,841,150.80
1927.....	1,914,400.00	94,443.39	325,000.00	2,333,843.39	44,871.29	2,288,972.10	1,926,910.12
1928.....	3,025,150.00	113,296.45	328,000.00	3,466,446.45	727,331.89	2,739,084.56	1,996,552.39
1929.....	3,444,594.67	103,000.00	185,500.00	3,733,094.67	126,600.22	3,606,494.45	2,286,705.35
Total.....	29,113,135.67	1,176,944.51	14,541,307.01	44,831,387.19	4,107,811.66	40,723,575.53	24,871,231.27
1930.....	2,395,670.00	109,000.00	135,000.00	2,639,670.00	.....	.....	2,212,870.00

¹ Includes printing and binding, stationery, and contingent expenses.

² Service items include Government fuel yards, helium, and other investigations and services for other departments.

³ Gas investigations for War Department.

⁴ Includes \$1,586,388 for Government fuel yards.

⁵ War Minerals Relief Commission, \$8,500,000.

⁶ Includes \$122,229.39 for mineral resources originally budgeted to Interior Department.

⁷ Balance of \$719,476.67, helium plants, reappropriated for expenditure in 1929.

⁸ Subject to adjustment until June 30, 1930.

⁹ Includes balance of \$719,476.67, helium plants, reappropriated for expenditure in 1929.

¹⁰ Unexpended balance, helium plants, reappropriated for expenditure in 1930.

¹¹ Subject to adjustment until June 30, 1931.

¹² Includes unexpended balance, helium plants, reappropriated for expenditure in 1930.

¹³ Appropriations, allotments, and transfers (exclusive of service items) as of July 1, 1929.

The annual expenditures of the bureau are illustrated in the curves entitled "Figure 1" and "Figure 2." Figure 1 shows the annual expenditures exclusive of service items and based entirely on regular duties and functions, and therefore presents the truer picture of the bureau's own activities since its establishment. Figure 2 includes all expenditures of every description.

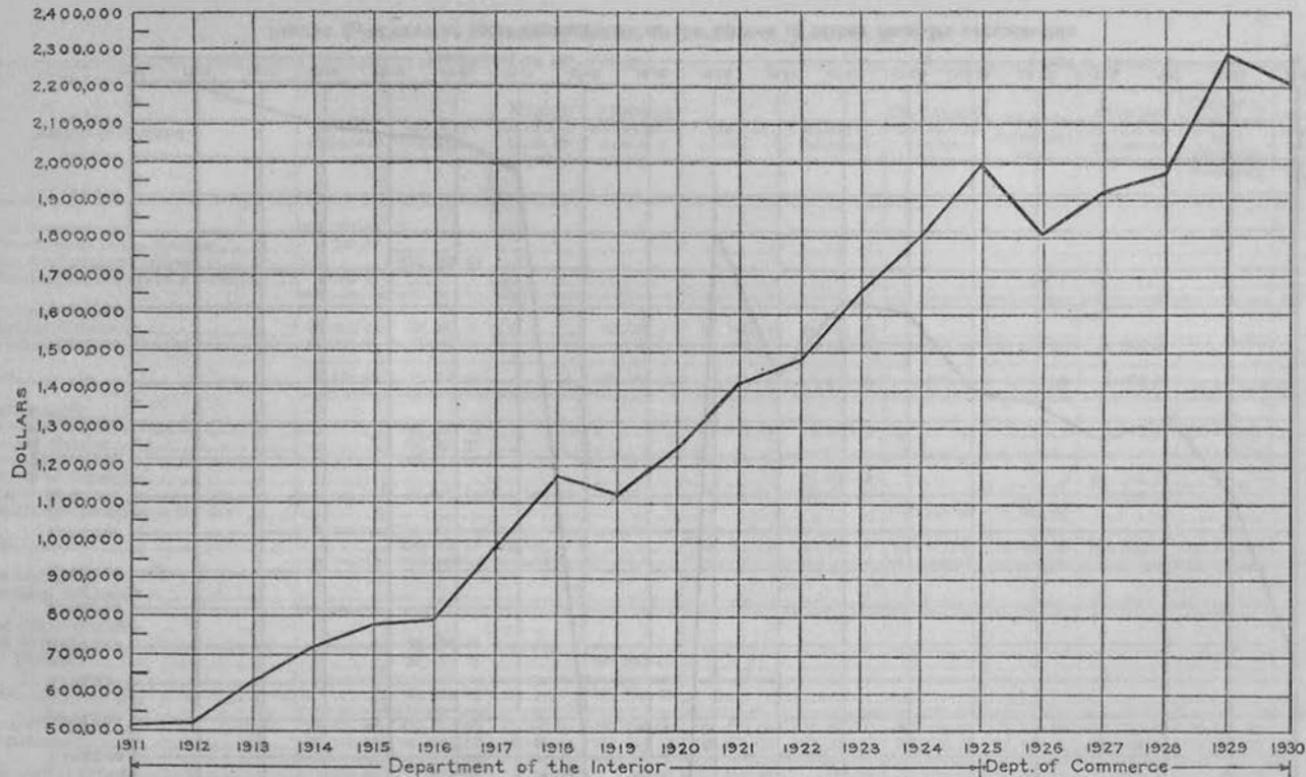


FIGURE 1.—Curve of annual expenditures of the Bureau of Mines since its organization (exclusive of service items)

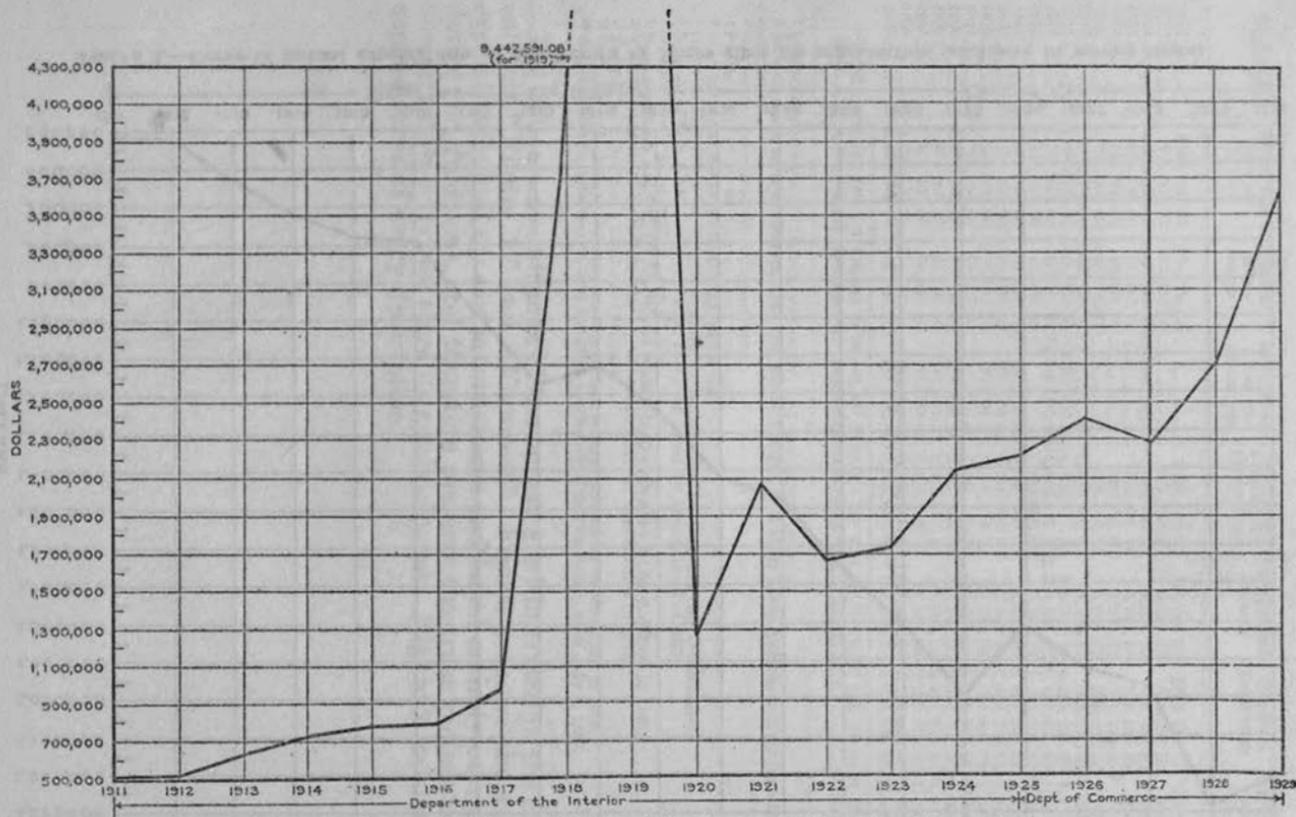


FIGURE 2.—Curve of total expenditures of the Bureau of Mines since its organization

TABLE 2.—Bureau of Mines expenditures, fiscal year 1929

Branch or division	General expenses	Mine accidents	Mining investigations in Alaska	Operating mine rescue cars and stations	Testing fuel	Mineral mining	Oil, gas, and oil-shale investigations	Oil-shale investigations	Expenses mining experiment stations	Care, etc., building and grounds, Pittsburg	Maintenance and operation Government fuel yards
Office of the director.....	\$12,530.46										
Office of the assistant to the director.....	9,257.47										
Office of the chief mining engineer.....		\$50,158.42									
Office of the director, convention travel.....	2,285.11										
Administrative branch:											
Information division.....	35,495.40	18,309.56		\$9,016.21	\$7,199.04	\$4,161.00					
Office administration division.....	31,933.02	5,014.84		7,067.17	7,062.82	3,159.55	\$8,975.44	\$3,763.33	\$8,002.48		
Total.....	67,428.42	23,324.40		16,083.38	14,261.86	7,320.55	8,975.44	3,763.33	8,002.48		
Technologic branch:											
Experiment stations division.....		101,346.22			45,986.44	6,178.58			7,800.24	\$82,276.53	
Explosives division.....		75,061.03									
Mechanical division.....		45,817.24			108,366.08						
Metallurgical division.....						79,336.14			194,766.57		
Mining division.....		33,841.14	\$11,146.40			38,460.99			6,225.27		
Petroleum and natural-gas division.....							198,977.67	73,380.29			
Total.....		256,065.63	11,146.40		154,352.52	123,975.71	198,977.67	73,380.29	208,792.08	82,276.53	
Economics branch:											
Government fuel yards.....											(1)
Health and safety branch:											
Health division.....		68,472.46									
Safety division.....		23,471.76		337,662.67							
Total.....		91,944.22		337,662.67							
Total appropriations.....	91,810.00	422,150.00	11,160.00	353,790.00	169,410.00	131,470.00	208,480.00	77,340.00	217,250.00	82,340.00	(1)
Total expenditures.....	91,511.46	421,492.67	11,146.40	353,746.05	168,614.33	131,296.26	207,953.11	77,143.62	216,794.56	82,276.53	
Unexpended balance.....	298.54	657.33	13.60	43.95	795.62	173.74	526.89	196.38	455.44	63.47	

¹ Revolving fund.

TABLE 2.—Bureau of Mines expenditures, fiscal year 1929—Continued

Branch or division	Helium production	Helium investigations	Helium plants	Investigating potash deposits	Economics of mineral industries	Mineral mining investigation, 1928-29	Operating mine rescue cars and stations, 1928-29	Signal service, Army	Printing and binding	Department contingent	Total
Office of the director.....											\$12,530.46
Office of the assistant to the director.....											9,267.47
Office of the chief mining engineer.....									\$760.11		50,918.53
Office of the director, convention travel.....											2,285.11
Administrative branch:											
Information division.....			\$3,667.17						2,410.00		80,258.38
Office administration division.....	\$5,201.50	\$7,049.99	8,596.29		\$18,296.72	\$1,497.50			2,161.89	\$27,878.31	145,660.85
Total.....	5,201.50	7,049.99	12,263.46		18,296.72	1,497.50			4,571.89	27,878.31	225,919.23
Technologic branch:											
Experiment stations division.....									4,592.42		248,180.43
Explosives division.....									397.49		75,458.52
Helium division.....									113.00		1,293,325.10
Mechanical division.....	174,589.21	71,128.94	1,047,493.95						5,944.18		160,127.50
Metallurgical division.....						23,446.30			6,796.88		304,345.89
Mining division.....				\$100,000.00					8,275.89		197,949.69
Petroleum and natural-gas division.....									678.75		273,036.71
Total.....	174,589.21	71,128.94	1,047,493.95	100,000.00		23,446.30			26,798.61		2,552,423.94
Economics branch:											
Coal division.....					52,290.55				5,040.96		57,331.51
Common metals division.....					27,534.92				2,183.88		29,718.80
Mineral statistics division.....					104,831.20				20,513.76		125,344.96
Petroleum economics division.....					38,529.16			\$5,468.01	3,151.86		41,681.02
Rare metals and nonmetals division.....					33,814.12				490.46		39,772.59
Total.....					256,999.95			5,468.01	31,380.92		293,848.88
Health and safety branch:											
Health division.....									70.66		68,543.12
Safety division.....							\$18,462.11		11,161.27		390,757.81
Total.....							18,462.11		11,231.93		459,300.93
Total appropriations.....	180,000.00	78,400.00	1,181,476.67	100,000.00	276,018.00	25,000.00	18,500.00	5,500.00	75,000.00	28,000.00	3,733,094.67
Total expenditures.....	179,790.71	78,178.93	1,059,757.41	100,000.00	275,296.67	24,943.80	18,462.11	5,468.01	74,743.46	27,878.31	3,606,494.45
Unexpended balance.....	209.29	221.07	1,121,719.26		721.33	56.20	37.89	31.99	256.54	121.69	126,600.22

¹ Balance of \$121,000 in helium plants reappropriated for expenditure in 1930.

PROPERTY

The books of the bureau, as of June 30, 1929, show property accounts as follows:

Real estate.....	\$1,612,885.60	Hardware.....	\$37,181.60
Laboratory.....	415,448.64	Household.....	25,088.59
Special equipment.....	370,532.22	Medical.....	11,789.43
Office furniture.....	399,988.23	Drafting.....	9,563.83
Power plant.....	1,781,485.16	Canvas.....	4,521.52
Automotive.....	98,632.28		
Electrical.....	59,861.17	Total.....	4,854,804.29
Photographic.....	27,826.02		

This property is distributed throughout the country at the various field stations and offices of the bureau.

ORGANIZATION

The major subdivisions of the bureau and the titles of the heads of each are as follows:

Branch.....	Chief.
Division.....	Chief engineer.
Section.....	Supervising engineer.
Unit.....	Engineer in charge.

The bureau is divided into four branches—the technologic, health and safety, economic, and administrative. Within these branches is a total of 16 divisions, 92 sections, 75 units, and 1 office. Some experiment stations are similarly divided as to administrative organization.

The studies of the bureau in those industrial sciences pertaining to its field of activities are conducted in the technologic branch, under the control of the various divisions in that branch. Much of the investigative work is done at the 11 experiment stations scattered widely over the country. This group of stations is administered in the experiment stations division, and each station gives special attention to the problems of the mineral industries of adjacent regions.

Within the technologic branch, the mechanical division is charged particularly with the study of problems of fuel utilization and investigations dealing with mining machinery, especially electrical equipment used in mining. The mining division gives attention to problems of economy and efficiency in mining, and the prevention of accidents. The explosives division studies the safe use of explosives in mining, giving particular attention to "permissible explosives." The petroleum and natural-gas division is concerned with the production, transportation, treatment, and utilization of these products. The metallurgical division deals with problems of efficiency in the treatment of ferrous and nonferrous metals. The helium division conducts research in its particular field and supervises the operation of plants producing helium for the military services.

The health and safety branch investigates hazards affecting the health and safety of workers in the mineral industries, with the object of determining causes and devising methods of prevention. The branch includes the health division and the safety division. The work of the health division is chiefly investigative. The effects of changes in the physical condition and chemical constituents of the

air, and insanitary surroundings, are studied, and recommendations made for improvement. The major activity of the safety division is instruction in mine safety and accident prevention and in mine rescue and recovery work; investigations include studies of the causes of accidents and methods of prevention.

The economics branch conducts studies dealing with economic conditions and problems, as distinguished from the scientific and technical problems of the mineral industries. The branch collects, analyzes, and publishes technical data relating to mineral economics. The branch comprises a coal division (including Government fuel yards), a petroleum economics division, a common metals division, a rare metals and nonmetals division, and a mineral statistics division.

The present chief of the administrative branch acts also as the assistant to the director of the bureau. The branch is composed of the office administration division and the information division. The office administration division, under the supervision of the chief clerk, is composed of accounts, personnel, clerical assignment, legal, multigraphing, mails and files, and property sections, and handles the general routine business of the bureau. A board, composed of the four branch chiefs and the chief clerk, recommends to the director all allocations, promotions, efficiency ratings, and other personnel changes. The information division, composed of the publications, editorial, motion-picture production, library, and graphic sections, handles all inquiries regarding the general work and publications of the bureau.

PRINCIPAL ACTIVITIES DURING THE YEAR

Before outlining in detail the work performed by the various branches and their divisions, a brief, general statement, summarizing the principal activities of the bureau during the fiscal year, is in order.

The bureau proceeded vigorously with its educational campaign designed to bring about safer and more healthful working conditions among the employees of the great mining, quarrying, metallurgical, and oil and gas industries. More than 81,000 of these workers were trained in first-aid or mine-rescue methods, the number surpassing by more than 30,000 that attained in any previous year, and bringing the total number so trained by the bureau since its establishment to approximately 365,000. At many large mining operations 100 per cent of the employees have been trained, resulting in decreases in the number of accidents. The bureau continued to vigorously urge the bituminous coal mining industry to generally adopt the practice of thoroughly rock-dusting mines as a means of preventing and limiting mine explosions. The explosibility of various coal dusts and the efficacy of varying percentages of different stone dusts in checking the explosion of these coal dusts were tested in the bureau's experimental coal mine at Bruceton, Pa. As approximately half of the fatal accidents in mines are due to falls of roof and coal, an intensive study of methods of reducing the number of deaths from this cause was conducted. The trend toward mechaniza-

tion in coal mines is resulting in a large increase in the number of types of mechanical mining equipment submitted to the bureau for testing, and the bureau's list of "permissible" electrical equipment, approved after thorough tests, now covers every activity for which such equipment is used in underground coal mining. An increasingly larger proportion of "permissible" explosives, which are far safer than other types, are being used as a result of the bureau's investigative work. The cooperative agreement between the bureau and the British Safety in Mines Research Board, designed for the exchange of mine-safety information, continued to function satisfactorily. The health and sanitation problems affecting workers in the mineral industries were given attention, especially with reference to poisonous gases, unwholesome dusts, and unhealthful conditions of temperature and humidity to which the miner is frequently exposed.

The special study of mining and milling methods and costs, as the result of which the bureau is presenting detailed data regarding conditions at representative operations in the various mining districts of the country, is arousing widespread interest in the industry and is assisting the operators in the solution of their economic problems. Increasing attention is being given to prospecting by geophysical methods, an interesting recent development that is assisting in the discovery of important mineral deposits heretofore unknown. The problem of mine subsidence, vital in many districts, is being studied. Fundamental data bearing on the subject of mine ventilation are being obtained.

In the field of metallurgy, the bureau continued to contribute to the practical conservation of the Nation's mineral resources through the development and improvement of methods for recovering more of the mineral content of ores, with attendant lessening of the cost of recovery. The bureau has been able to render effective service in the improvement of methods for the treatment of the complex or low-grade ores on whose development the prosperity of the Western States largely depends. Fundamental metallurgical data, vital to the progress of metallurgy, are being provided by the bureau. Because of recent great activity in the quicksilver industry, a study of the technology and economics of the subject is being conducted.

Valuable fundamental data on the smelting of iron ores are being obtained. Progress was made in the effort to develop methods for the profitable recovery of the manganese content of the low-grade mangiferous iron ores of northern Minnesota and for the beneficiation of various types of low-grade manganese ores, with the ultimate object of making available domestic supplies of this material, essential in the manufacture of steel and therefore a commercial and military necessity. Studies of the physical chemistry of steel making, designed to eliminate unscientific and wasteful practices, were continued.

Research was continued looking to the more efficient mining, treatment, and utilization of the numerous important nonmetallic minerals, which are widely used in the construction of buildings and highways. Special attention was given to the problems affecting the phosphate, bauxite, kaolin, and other industries. In the course of

the effort to discover commercial potash in the United States, core drilling in the salt beds of New Mexico and Texas was actively continued. A study of the possibility of the marketing of potash salts derived from polyhalite, the principal potash mineral so far discovered, is being made. Under the provisions of a recent bill, similar studies regarding the availability of leucite, alunite, greensand marl, and other potash-bearing materials are being made.

The bureau is continuing its studies designed to assist the great petroleum industry in the development of methods of production whereby more than 20 per cent of the oil in underground deposits can be recovered, and in devising processes by which larger percentages of motor fuel and other commercial products may be obtained in the refining of petroleum. By conducting special engineering studies of important oil-producing fields, the bureau is assisting operators in their efforts to control such underground water as threatens continuance of successful development. The bureau has now issued more than 450 publications giving the results of technologic research having a direct bearing on the conservation of petroleum and natural gas, those irreplaceable resources vital to the Nation's commercial development and to the national defense. Data obtained from the operation of the experimental oil-shale plant, Rifle, Colo., which was closed on June 30, 1929, should assist materially in solving problems connected with the possible establishment of an American oil-shale industry. The bureau's safety program has been extended to the oil and gas industries and in the Seminole (Okla.) field alone 3,000 men were given first-aid training.

The new helium production plant near Amarillo, Tex., began operation in May, 1929, and at the close of the fiscal year was in steady, successful operation, producing helium at a price much lower than has ever before been attained anywhere.

The bureau has continued to study problems in efficiency in the use of fuels, a field in which it has been a pioneer. This work includes the making of thousands of analyses of coals, the study of combustion problems, the utilization of low-grade fuels, the prevention of smoke, the study of new types of fuel, the preparation of coal, and the carbonization of coal with attendant conservation of by-products. As the result of the bureau's fuel-economy service, large sums are being saved annually in the operation of Government heating and power plants.

In addition to studying the scientific and technical problems of the mineral industries, the bureau is giving increased attention to economic conditions and problems. This involves the collection and dissemination of statistical data regarding the production, consumption, distribution, and storage of the numerous essential minerals.

WORK DONE BY EACH BRANCH

The work of the bureau will be described in detail in the order indicated by the organization chart, reading from left to right. The branches are dealt with in the chronological order of their formation, the technologic branch being the oldest and the administrative branch the youngest.

WORK OF THE TECHNOLOGIC BRANCH

MECHANICAL DIVISION

The mechanical division conducts studies dealing with the efficient use of fuels and investigates and tests electrical and other mining machinery and equipment. The bureau was a pioneer in the study of the fundamentals of fuel combustion and the transmission of heat. Before its establishment, very little definite information was available regarding the characteristics of the coals produced in the United States. The bureau has conducted tests of large numbers of coals from every producing district, to determine their steaming, gas-producing, coking, and briquetting qualities. Analyses of many thousands of coal samples have been made.

Methods for the practical utilization of the vast stores of lignite, which comprise one-third of the Nation's coal reserves, have been demonstrated. The newer developments in fuel technology, such as the combustion of powdered coal and the low-temperature carbonization of coal, have been studied. Attention has been given to the use of new materials and new methods in the manufacture of illuminating gas and to obtaining more and better by-products in the coking of coal. The results of this extensive program of investigation have been made public in numerous bulletins, which afford helpful information to the coal operator, the coal marketer, and the coal consumer. The United States is by far the greatest coal producing and consuming nation, and the bureau has endeavored to point the way to the more efficient utilization of the Nation's extensive supplies of raw fuel.

While the increasing electrification of coal mines in the United States has largely enabled American miners to produce more coal per capita than those of other nations, the introduction of electrical equipment has been attended by new hazards. The emission of electric flashes and sparks may ignite accumulations of mine gases and coal dusts, and thus cause disastrous mine explosions. The Bureau of Mines has encouraged the development of "permissible" mine machinery and equipment, which, when properly used, reduce such hazards to a minimum.

ELECTRICITY IN MINES

The electrical section interests itself in the use of electrical equipment in mines, flame safety lamps, and apparatus for detecting mine gases. The work, performed at Pittsburgh, consists largely of tests of apparatus designed to meet the bureau's schedules for "permissible" apparatus covering the following subjects: Electric motors, switches, and junction boxes to be used in the operation of electrical equipment in mines; electric cap lamps, miscellaneous electric lamps, flash lamps for use in the presence of methane and flash lamps for use in the presence of gasoline vapors; portable methane detectors; single-shot blasting units; and electric locomotives. These schedules give the minimum requirements that must be met to win the bureau's approval as "permissible."

Conformity to these "permissible" schedules is optional with the manufacturer and user of the equipment, save in a few States where the State mining law has made the use of "permissible" equipment compulsory. They have become an essential part of the activities of the bureau along safety lines and in giving manufacturers of safety equipment a minimum standard of construction and performance.

The trend toward mechanization in coal mines has resulted in a large increase in the number of types of equipment submitted for approval. During the year 28 new approvals were granted, increasing the total number granted up to July 1, 1928 (110), by almost 25 per cent. A proportionately large number of extensions to approvals already granted was issued. These extensions cover variations in design or arrangement of equipment for which approval had previously been granted.

Trailing cables used to supply current to "permissible" machines of the portable type are being investigated in order to obtain data which will permit the selection of certain types of such cables as being safer than others for the exacting service expected of permissible equipment. Concentric-type rubber-sheathed cable and parallel-duplex type of rubber-sheathed cable have been studied and preliminary reports issued. It is planned to complete the series by making a similar study of other types of cable not already included in the first two series of tests.

Fundamental data are being obtained on the ignition of natural gas by heated surfaces and of the temperature of ignition of petroleum vapors. These data will be valuable in the approval work and will have a direct bearing on the safety of equipment used in mines and where petroleum vapors are present.

Electrical safety codes and regulations from various sources have been compared, and the relative emphasis placed on safety in the use of electrical equipment in coal mines in the various States and in certain European countries has been studied. The purpose is to give assistance to the various States in revising their mining laws and to compile a uniform code governing the installation and use of electricity in coal mines.

EFFICIENCY IN THE USE OF FUELS

Fuel inspection and coal analysis.—The fuel inspection section acts primarily as a means of determining the fuel value of American coals. The practice is to determine the quality of coal delivered to Federal departments and to such State and municipal institutions as will avail themselves of the assistance rendered, and to advise on the purchase of coal. Coal is also inspected and sampled in the mine, at the tippie, and in some cases at the point of delivery. Analyses are reported to the interested parties, and assistance is rendered in the preparation and execution of fuel contracts. During the year samples from 55 mines in Illinois, Maryland, Pennsylvania, Virginia, and West Virginia, and of 31 cargoes of coal at tidewater piers were collected and analyzed. Methods of collecting samples were investigated at four points of delivery in cases where the results of analyses and sampling methods were in question.

Analyses were also made of samples of coals purchased by the United States Government on specification by the following organizations: War, Navy, Treasury, Agriculture, Post Office, State, Labor, Justice, Commerce, and Interior Departments, National Homes for Disabled Soldiers, District of Columbia, Panama Canal, Panama Railroad, United States Coast and Geodetic Survey, and United States Shipping Board. In addition, similar work is carried on cooperatively with the States of Maine, Maryland, New York, and New Jersey, with various State geological surveys, with municipal governments, and with the American Gas Association and the American Society for Testing Materials. All coal samples collected by different sections of the bureau in their various investigations are likewise analyzed. The exchange of samples with several commercial and industrial laboratories is for the purpose of checking methods of analysis. This work results in maintaining a high standard at these laboratories. Analyses are often made of umpire samples and samples of coal intended for export. During the past fiscal year 106,046 determinations were made on 9,327 samples.

During the year Technical Paper 405, tabulating the analyses of coals of West Virginia, was issued. Data were assembled for similar papers on the analyses of coals from Kansas, Maryland, Colorado, Washington, Wyoming, Montana, Illinois, Michigan, Texas and Mississippi, New Mexico and Arizona, and California, Oregon, Nevada and Idaho.

Fuel-economy service.—The fuel-economy service consists of power-plant studies, fuel-efficiency tests, studies as to the proper selection of coal, acceptance tests of new equipment, and acting in an advisory or consulting capacity on many fuel problems coming to the bureau from many Government power plants, particularly recommendations regarding the plans, specifications, and purchase of new equipment, all with the object of saving fuel in Government plants.

As the result of the work of the fuel-economy service, large savings have been made to the Government in the operation of various heating and power plants. This has been accomplished by testing and changing equipment, training firemen, the use of different firing methods, changes in class of fuel used, etc. At the central heating station at Fort Leavenworth, Kans., where an appropriation of \$300,000 had been requested by a department, the Bureau of Mines found that equally satisfactory results could be obtained with an expenditure of \$7,300. At the District of Columbia sewage-pumping station power plant, the yearly saving in coal effected is about \$4,100; at Soldiers' Home, \$3,500. At the District Tuberculosis Hospital, where an appropriation of \$48,500 had been asked, the bureau found that \$3,500 would suffice. Substantial savings have been effected at numerous other governmental institutions; the wisdom of having the Bureau of Mines serve Government in a general advisory capacity as to fuel has been amply demonstrated.

Refractories service in boiler furnaces.—Combustion engineers and manufacturers of boiler-furnace refractories require a knowledge of the conditions in boiler furnaces and their effects on the life of boiler settings and the conditions to which the refractories are subjected in

order that they may avoid rapid deterioration, and increase the relative life, by the selection of proper refractories and the use of proper types of furnace construction. An investigation of these conditions has been conducted, in cooperation with a special research committee of the American Society of Mechanical Engineers, the Bureau of Standards, and the University of Illinois. The investigation followed three lines: First, a study of the physical and chemical conditions found in boiler furnaces; second, a study of the properties of and the mineral systems in the slags found in boiler furnaces; third, the development of a method for determination of slagging properties of refractories, and the relations between quantitative loss by slag action, type of slag, type of refractory, and the furnace temperature and gas composition. A bulletin covering the bureau's part of the work is in course of preparation.

Burning problems of refractory kilns.—For some years the bureau has been investigating the use of fuels in kilns for making refractories. During the year, a study was made of the use of fuels in continuous kilns, and the present status of the knowledge of the problem reviewed to learn what further investigation is most needed.

Fusibility of coal ash.—Intensive studies have been made of the nature and distribution of ash in a number of coals, and of clinkers and ash residue formed when the coals were burned. The variation in ash and the fusibility of ash from different benches of coal at one point, and from different points in the same mine, were compared. The relation between the fusibility and composition of the coal was determined. To study the practical application of this information, tests were made in cooperation with one industrial company in which five coals, similar except for the nature of their ash, were burned in the furnace of a large boiler. In another investigation, the removal of ash as a molten slag, from a furnace burning pulverized coal, was studied.

Standard rating of heating boilers.—The bureau cooperated with the American Society of Heating and Ventilating Engineers in preparing a much-needed standard code for the testing and rating of low-pressure steam-heating boilers. This necessitated an investigation of methods of testing to insure uniform conditions in rating.

Burning qualities of high and low temperature coles.—In order to compare the relative values of high and low temperature coles as domestic fuel, the characteristics of the two fuels were studied in a special furnace in which the variables could be controlled. A method of testing in this furnace was developed.

Ignition and burning of individual particles of powdered fuels.—Exact knowledge of the ease of ignition and rate of burning of powdered coal and coke are of interest to the combustion engineer from a fuel-burning standpoint, and to the mining engineer from a safety standpoint. The influence of the nature of the fuel, the particle size, and the temperature, on the rate of burning of the individual particles of powdered fuels, is of great importance in the economical use of powdered fuels and in the design of powdered-fuel installations. The first fundamental data on the rate of burning of the individual particles of powdered charcoal, beehive-oven coke, and low-temperature coal and coke were obtained.

The relative explosibility of suspensions in air of powdered semicoke and coal under different conditions of particle size and concentration is of importance in the study of explosion hazards in mines and industrial plants. It was found that the ignitibility and rate of propagation of flames in semicoke dust clouds are much less than in clouds of coal dust. The explosibility hazards with semicoke dust are much less.

Origin and constitution of coal.—A study of the origin and constitution of coal is especially important in connection with the carbonization of coal and the spontaneous combustion of coal in storage. In investigating the origin of coal, a study was made of the chemistry of decay in relation to peat and coal formations.

Slacking test for coal.—Slacking of coal when exposed to the weather is important in connection with storage, shipment, and spontaneous combustion. It is also one of the characteristics used in classifying coals according to rank. Accelerated methods of testing the slacking characteristics of coal are being investigated. A promising method consists of the alternate wetting and drying of pieces of coal approximately $1\frac{1}{4}$ -inch cubes, and measuring the amount of fines passing through a sieve with $1\frac{1}{4}$ -inch square openings. Experiments with subbituminous coal and lignite indicated that the accelerated method of test showed wide differences in characteristics between these ranks of coal.

CARBONIZATION OF COAL—BY-PRODUCTS OF COAL

Methods for determining gas and coke making properties of American coals.—There is no standardized moderate scale method at present available whereby a coal may be tested by carbonization at high or low temperatures as to the quantity and quality of carbonization products it will yield. The purpose of this study is to develop such a method and at the same time obtain fundamental information on the carbonizing properties of American coals. The work of 1928-29 consisted of a critical study of carbonization-test methods and of consultation with engineers and chemists experienced in coal carbonization with a view to arriving at a feasible scale of test. Heretofore little reliance has been placed on small-scale tests; engineers have in general required a test of a coal in an industrial plant before deciding as to its suitability for gas or coke making. Plant-scale tests, however, are expensive, and it is highly desirable to have standardized a smaller-scale test which will give the information required. With the critical study of available test methods as a basis, apparatus for testing coals as to their carbonizing properties has been designed and built at the Pittsburgh Experiment Station. The products obtained are very similar to those obtained in industrial practice, both as regards quantity and quality.

Effect of inerts on coking properties of coal.—It has been observed that on carbonizing the fine coal (slack) produces a coke inferior in quality to that obtained from coal of larger sizes. The purpose of this study was to investigate this point and to find the effect of inerts perhaps present in significant amounts on the coking power of the coal. A study of the effect of fusain on the strength of coke made from Pittsburgh coal shows that fusain up to 38 per

cent of the coal actually improves the quality of the coke made therefrom. Since it is not present in excess of this amount in the slack coal some other factor must be responsible for the inferior coke produced in practice from the fine sizes of the coal. The effect of inerts other than fusain (mineral inerts in particular) on the coking power of Pittsburgh coal will be studied.

Determining the coking properties of coal by the benzene-pressure extraction method.—The purpose of this investigation was to apply to American coking coals the benzene-pressure method of study developed by Fischer at Mulheim, Germany, and find if it would elucidate their caking and swelling properties as stated by Fischer, who has extracted from coking coals a solid oxygen containing bitumen and an oily hydrocarbon bitumen. Results of the study show that, when mixed with the extracted coal residues, solid bitumen does promote swelling on subsequent coking, but that it also has stronger coke-cementation properties than the oily bitumen.

Composition of low-temperature tar.—Although processing coal by low-temperature carbonization methods has not yet been established industrially, it seems probable that it will be in the future, and it is desirable to have a knowledge of the nature of the products obtained, both to serve as a guide in their evaluation and as a basis for the development of new uses for them. A low-temperature tar produced by carbonization of a Utah coal, in superheated steam on a semicommercial scale, has been carefully analyzed. The work of the current year has consisted in a study of the waxes found in this tar and analyses of three low-temperature tars now being produced experimentally on an industrial scale. The wax proved to consist mainly of hydrocarbons, of high melting point, apparently well suited to the manufacture of crayons, wax paper, candles, and the like, where a high-melting wax is desirable. In the course of the investigation of the composition of low-temperature tar, a number of compounds have been found whose properties are imperfectly known. Such compounds were synthesized and their properties studied with a view to discovering means of their utilization, and of readily determining them in the tars in which they occur.

Agglutinating power of coal.—Various methods of testing coal as to the binding power of its coking constituents have been proposed and studied. At present there is no standard procedure for making tests of this sort and the test data available have not been properly correlated with the coking behavior of the coals in question in industrial practice. The object of the present problem is to study present methods for investigation of agglutinating power, improve upon them if possible, and secure better correlation of data with industrial practice. A further objective is to obtain additional fundamental information on the mechanism of coke formation.

Investigations of manufactured gas.—The purpose of this investigation is to assist the gas industry by studying the utilization of new materials and new methods in the manufacture of city gas. This investigation covered various problems regarding the mixing of natural gas and manufactured gas, to obtain a product of constant fuel value under varying ratios of the available supply of natural gas to the demand. Studies were made at one operating gas plant and will be continued at another designed primarily for the purpose.

Hydrocarbon synthesis from water gas.—The purpose of this work is to develop suitable catalysts and methods for operating the process for the production of petroleumlike products from water gas made from coal. The work is a part of the general problem of the better utilization of coal. The aim is also to assure a future supply of liquid fuels. Methods have been discovered for greatly increasing the amounts of liquid fuels obtainable from coal through the medium of water gas. Better catalysts and methods for controlling the nature of the products have been developed.

Formation of methanol from water gas.—The production of methanol, from water gas made from coal, furnishes a product of value as a liquid fuel and for many other purposes. When reliable scientific information is lacking on the optimum results possible in any process, much time can be wasted in useless attempts to improve the process. Such information on the methanol process is furnished by this investigation.

MINING DIVISION

The work of the mining division relates principally to improvements in mining methods, with the object of reducing loss and waste in mining and preventing accidents. The investigations of the division include such matters as drilling and blasting, the loading of ore and coal, mine timbering, the breaking and handling of ore and coal, mine ventilation, underground transportation, mine sampling methods, efficiency of mine labor, and mining costs. The division is preparing an extensive series of reports giving detailed data regarding mining and milling methods and costs at representative mines in the different districts of the country, these reports being prepared by the bureau's consulting engineers, who are the managers and engineers in charge of these mining and milling operations. It is believed that this free discussion of mining and milling problems in governmental publications will be an aid to operators in overcoming their technological and economic difficulties, and will help in increasing metal recovery and in reduction of production costs. Special attention is being given to the subject of geophysical prospecting. The subsidence of land after mining operations is also being investigated. As falls of mine roof and coal are responsible for approximately half of the accidental deaths in the country's coal mines, a special investigation of this problem is being conducted. In the effort to develop domestic sources of supply of potash and to make American farmers independent of foreign domination of this essential fertilizer material, the bureau is exploring certain areas in the Southwest in which beds of potash-bearing salts have been found.

Mining and milling methods.—In this investigation of mining methods and local treatment of the mineral products, the basis is present practice at the individual mine; to make the study especially instructive, mines representative of a district, of a certain mining method, of a typical mode of ore occurrence, and of a particular metal are selected.

The mining division has prepared outlines for papers on both mining and milling practice, and tables for recording efficiency results and costs, in order to have all the reports uniform and readily comparable. These outlines are given to the mine or mill operator,

who is usually given a temporary appointment as a consulting engineer to the bureau.

This work was started during the last fiscal year and thus far 70 such engineers have been temporarily engaged, all of whom are preparing reports on their operations. Already eight of these have been issued as information circulars and many others should be ready for publication within the year. Since the bureau is without adequate printing funds, it is forced to issue all these reports in mimeographed form.

In the preparation of these papers attention is given to the type of deposit and conditions determining the selection of mining methods used; the methods employed to meet these conditions; and the results obtained in safety, cost, and extraction of ore. Particular attention is given to the tonnage produced per man and per machine underground, to unit-supply consumption, and to problems of underground mine support and ventilation. Comparative data are being obtained on the percentage of ore lost by the use of the different stoping methods and on the dilution of the ore by waste as mined by each method. Studies are being made of the loading and transporting of ore; cost of hoisting; wage, contract, and bonus system; and administrative organization. Bulletins are in preparation dealing with the caving system of mining, based on operations at various large western mines, and on open-stope methods, based on operations in southeastern Missouri, the Tri-State District (Missouri-Kansas-Oklahoma), Tennessee, Michigan, and Minnesota. Other bulletins to follow will deal with the top-slicing, sublevel caving, square-set, shrinkage, and cut-and-fill methods of mining.

The methods of milling at important characteristic plants will be studied, and analyses will be made of the cost of treating ore under different conditions. The final objective is to give the mine operator, the mill superintendent, the consulting engineer, and the mining professor and student, a series of papers from each mining district on present mining and milling practice and cost. Eventually, bulletins on each method of mining and milling, giving details of its application in the different districts, will be issued, provided adequate printing funds can be secured.

These publications will form the basis of special research on separate mining and milling problems which should result in reducing costs and metal losses, and in an increased metal recovery from the Nation's mineral resources.

Subsidence and ground-movement studies.—The mining industry is recognizing the importance of the study of factors that cause breaks and movement of rock and ore masses, and of the lines of weakness along which failure usually occurs due to mining operations. This investigation involves a study of conditions of occurrence of the ores and associated formations and their relation to rupture in open-cut and underground operations. The object sought is the collection of fundamental information affecting and controlling subsidence and ground movement, in order to determine the factors involved and to suggest precautionary and remedial measures to insure mine workings against failure and resulting damage prior to the extraction of available ores. During the year, a bulletin was published dealing with subsidence in the copper and iron

mines of Michigan; another on rock bursting, or the failure of supporting pillars in certain copper mines in Michigan, was prepared. At present, similar studies are being made at western copper mines using the caving and open-pit methods of mining. The work will later be extended to other districts.

Mine ventilation.—Ventilation surveys have been made at certain copper and iron mines in Michigan, and they are now in progress in the Arizona mines. The direction and quantity of air currents due to natural and mechanical ventilation are determined, and where the quantity is deficient in certain sections of the mines, recommendations to improve this are made in confidential reports to mine officials. After a number of mines in a district have been surveyed, a summary report is prepared on the ventilation problems encountered, with proposals for their solution. In the coming year, it is planned to concentrate on the correlation and dissemination of data in the performance of commercial types of mine fans.

Shaft sinking.—It is the purpose of this study to present in detail the modern methods of shaft sinking and to give unit costs for shafts of various sizes and shapes, and in various rock formations, in such a way as to be of value to the operator in the solution of his own shaft-sinking problems.

Drilling and blasting in drifts.—The object of this investigation is to ascertain the best methods of drilling drift rounds, and the safest and most efficient explosive to use under various conditions. These results have led to a classification of the most economical combination of explosive and system of holes for each type of ground. The results of the investigation are being published as Bulletin 309.

Mine sampling and estimating.—The bureau is planning a study of the latest and most approved methods for sampling the various types of ore deposits, to determine the best use of each and to show how assay results should be interpreted and how estimates of ore reserves can be made. The result of this study should lead to more uniform methods.

Diamond-drilling methods.—A study has been made of the methods and costs of diamond drilling, the results of which should be of value to the operator in lowering the cost of exploration. An information circular entitled "Special Features of Core Drilling in the Salt Beds of Western Texas and New Mexico," describing the methods used under different conditions, has been prepared.

Safety organizations in Arizona metal mines.—A survey of safety organizations at metal mines in the Southwest was undertaken in order to give publicity to the most desirable features of such organizations. The accident rate, it was found, was not primarily affected by the particular form of safety organization in vogue at each mine, but rather depended upon the spirit in which accident-prevention work was carried on. Where accident prevention was considered a major operating problem, low accident rates were obtained. A formal safety organization, however, with a safety engineer at its head, was helpful at most places, in keeping the work coordinated and in reducing the accident rate. The results of the survey were published as Technical Paper 452.

Geophysical methods of prospecting.—The study of geophysical prospecting has been undertaken with the view of determining, by

a series of field tests, the actual value of the numerous methods of ore detection, and to inform prospectors to what extent they may be aided in their search for new mineral deposits by these methods. Considerable field work had previously been done in testing the value of certain electrical methods, and similar work is now being done by improved methods, at other localities on known mineral deposits.

The results of some of the geophysical investigations have been published in the following reports:

Technical Paper 434, Geophysical Prospecting: Some Electrical Methods.

Technical Paper 440, Measuring the Variation of Ground Resistivity with a Megger.

Technical Paper 444, Graphical Terrane Correction for Gravity Gradient.

Information Circular 6141, Tentative Method for Making Resistivity Measurement of Drill Cores and Hand Specimens of Rocks and Ores.

Papers soon to be published deal with geophysical investigations at Caribou, Colo., and with the depth limitations of various electrical methods of geophysical prospecting.

In order to make available the latest published contributions to this new branch of science in domestic as well as foreign publications an abstract journal is being published monthly. Some of the leading men in this profession have volunteered as contributing editors. Translations are made directly from German, Russian, French, and Japanese for this publication.

Cooperative work with the Canadian Geological Survey has resulted in extending the scope of this work with a great economic saving to both parties.

Coal-mining methods and costs.—A study of coal-mining methods and costs, similar to the investigations being conducted in the metal-mining field, is being made. In this study, representative mines from the more important districts will be made the basis of reports in which the methods of development and mining will be described. Data on operating costs and efficiency will be given, and safety measures will be outlined. Information circulars covering four mining plants in western Pennsylvania and two plants in Ohio have been prepared.

Falls of roof and coal.—More than half of the fatalities in coal mines result from falls of material from the roof and sides, and a study of mines has continued during the year to determine the methods employed to support the roof and sides of coal mines as a means of prevention of falls in those parts of the mine where men are engaged in work. The cooperative study with the Department of Mines of West Virginia has been continued. As a result of this cooperative study there has been a favorable reaction toward the adoption of standard timber regulations by some of the larger companies. The study in Pennsylvania mines has also been continued, 14 mines having been reported upon, and a review of conditions in one district being in preparation as an information circular. The work was extended to mines in the State of Ohio and reports issued on five mines. Arrangements were completed for the extension of this study in the western coal-producing States for the coming year. There have been issued during the year the following publications: Technical Paper 410, Falls of Roof in Bituminous Coal Mines, In-

fluence of the Seasons; Miners' Circular 31, Questions and Answers on Timbering Bituminous Coal Mines; Information Circular 6093, Factors Affecting Falls of Roof and Coal; and Information Circular 6110, Review of State Mine Inspectors' Reports as They Relate to Accidents from Falls of Roof.

Search for domestic potash supplies.—In the course of the effort to locate commercial potash supplies in the United States, core drilling in the salt beds of New Mexico and western Texas was actively continued. Four wells were drilled in western Texas, bringing the total number of wells completed to 12. These four wells, all in Texas, were situated as follows: No. 9, Regan County; No. 10, Glasscock County; No. 11, Crane County; No. 12, Winkler County. The total footage drilled during the year was 8,364 feet 2 inches, of which 4,495 feet 2 inches were in the overlying formations above the salt beds and were drilled with a churn drill taking no core, and 3,869 feet 4 inches were core drilled in the salt formation. Core recovery was 100 per cent, no core being lost; this constitutes a remarkable record.

Potash salts were found in all four wells in numerous thin beds, but, on the whole, the year's showing was disappointing in that the beds discovered are too small to be of present commercial importance. The four wells drilled during the year on the eastern and southern rim of the large salt basin have indicated that those portions of the basin are less likely to contain commercial deposits of potash salts than the western rim, and drilling activity has been shifted to more promising territory in southeastern New Mexico. Well No. 13 is now being drilled in Eddy County and contracts have been let for the drilling of No. 14 in Lea County, No. 15 in Eddy County, and No. 16 in Chaves County.

The principal potash mineral so far discovered is polyhalite, a sulphate of lime, magnesia, and potash. Polyhalite was thought at first not to be of economic importance, on account of treatment difficulties. Investigations during the year by the Bureau of Mines have indicated that these treatment difficulties were not as formidable as they seemed and that polyhalite does possess important commercial possibilities, together with special advantages. A report on the production costs and possibilities of the marketing of potash salts derived from polyhalite has been prepared and will be issued soon.

An information circular entitled "Special Features of Core Drilling in the Salt Beds of Western Texas and New Mexico," discussing those details of drilling technique which are peculiar to this type of drilling, is in process of being printed. A complete bibliography of potash literature was completed during the year, but will be indefinitely delayed in publication due to shortage of printing funds.

Work in Alaska.—The mine-safety work in Alaska is conducted by a foreman miner assigned from the Bureau of Mines staff. A fully equipped mine-rescue car is maintained on the Alaska Railroad and kept available for service at all coal mines adjacent to the railroad. The car is also used for conducting first-aid and mine-rescue training in that area. Oxygen breathing apparatus and other mine-rescue equipment are maintained at Juneau for use at any disaster that might occur in the mines of southeastern Alaska. First-aid

training was given at a considerable number of mines during the year, and the importance of this work in the prevention of accidents in Alaska is being more fully realized than heretofore.

Assaying and mineral-analysis work was conducted by the bureau at the Alaska Agricultural College and School of Mines at Fairbanks. This service provides prospectors and others in Alaska with means of obtaining official assays of ore samples at actual cost, and of having identification tests of mineral specimens made free of charge.

Analyses of samples of coal are made by the bureau in a well-equipped laboratory furnished by the Alaska Railroad. All coal purchased by the railroad under contract from private operators is inspected, sampled, and analyzed by the bureau. The facilities of the coal-analysis service are available to other branches of the Government and to the public.

METALLURGICAL DIVISION

The field of metallurgy presents great opportunities for the research specialist to contribute to world progress by devising methods for the recovery of minerals essential to the comfort and welfare of mankind; without the knowledge obtained from research, many such materials would be discarded as waste. Each year millions of dollars' worth of metals are being recovered from complex or low-grade ores that formerly could not be worked profitably. Metal losses in milling that once reached huge amounts annually have in late years been greatly reduced. The Bureau of Mines has taken an active part in the technologic progress of the metallurgical industry and through its investigative work constantly seeks to focus the attention of the industry upon wasteful or inefficient practices, to point out improvements, and to obtain the cooperation of producers in adopting better methods and putting into use more efficient devices.

The metallurgical division places great emphasis on investigations of a fundamental nature, leaving the application of the general principles discovered, the data determined, or the formulas developed, to those operating companies needing the information. In this category come its studies of physical chemistry of steel making, crushing and grinding of ores, flotation fundamentals, reactions in the blast furnace, specific heats and heats of formation of oxides and sulphides, rates of reactions of various metallurgical materials, solubility studies, etc. All of these data are basic in the industries to which they apply, and equally concern all those within the industry.

One of the major activities of the metallurgical division during the past year has been the development of methods which can be applied to the production of manganese from low-grade domestic deposits. These studies have been carried out by the ferrous, nonferrous, and ore-dressing sections of the division. The ferrous metallurgists have worked on a pyrometallurgical process for producing manganese from manganiferous iron ores, the nonferrous metallurgists have studied hydrometallurgical methods, and the ore dressers have devised mechanical methods of concentration. All have shown encouraging progress.

A recent bill authorizing an extensive investigation of extraction of potash from its minerals gave great impetus to the potash research

already under way at the bureau's Nonmetallic Minerals Experiment Station, New Brunswick, N. J. It allowed the expansion of the potash program to include leucite and alunite, as well as polyhalite and greensand.

A significant research of the division has been the application of methods devised for the study of the interior of iron blast furnaces to similar exploration in the lead furnaces. The findings from this study should lead to improved practice and increased efficiency in the important lead-smelting industry.

FERROUS METALLURGY

Physical chemistry of steel making.—Too frequently, the plant metallurgist who is faced with the problem of improving the quality of steel produced under his direction resorts to cut-and-try experiments to find the cause of difficulties. Such methods are unscientific and wasteful. If fundamental information applicable to the problem is available, operating difficulties can be solved without recourse to further experimentation. The Bureau of Mines, therefore, at its Pittsburgh Experiment Station, three years ago initiated a program for the determination of many of the fundamental physical-chemical principles of steel making. The results of the work to date have amply met the expectations; the application of the data obtained has in several cases produced the cleanest steel ever made by the various furnaces applying the bureau's findings. The problems under present consideration include:

1. Distribution of iron oxide between slag and metal. During the past year, slags containing iron oxide and silica have been studied and the dissociation constant of the compound fayalite has been determined. Future work will deal with slags whose base is lime and iron oxide, containing small amounts of silica, manganese oxide, and other oxides commonly met in the steel-making process.

2. The formation and identification of nonmetallic inclusions in steel. During the past year a series of aluminum-silicon alloys and of aluminum-manganese alloys has been completely investigated. The types of inclusions resulting from deoxidation and the degree of deoxidation obtainable with an aluminum-base alloy have been determined. Work is now in progress with manganese and silicon-manganese alloys.

3. Nonmetallic inclusions in the basic open hearth. Plant work is carried on to correlate the laboratory studies on deoxidation with operating conditions and to determine the effect of inclusions on the quality of the steel produced. During the past year a comprehensive study was made on the action of silicon on reboiling basic open-hearth heats at various carbon contents and in various sizes of furnace. Similar work, using spiegel, will be undertaken. Tests on the rate of rise of inclusions in steel showed that while the steel was held motionless in the ladle the inclusion content in the lower layers of metal decreased, but during pouring it increased. A study was begun on the effect of inclusions on the rolling qualities of seamless-tube steel. Correlation of inclusion-content with shipping costs, tube rejections, etc., is now in progress. The factors affecting the segregation of inclusions in large-size ingots are also being studied.

4. Methods of determining nonmetallic inclusions in steel. During the year an electrolytic method of determining nonmetallic inclusions in steel has been developed. It is much more rapid and gives better recoveries of low-silica silicates than the Dickenson method. It is also as accurate as the Dickenson method on killed steels.

5. Viscosity of open-hearth slags. Slag viscosity is a very important factor in open-hearth operation, since it affects the ease of diffusion of oxides between slag and metal, ease of slag removal, etc. Determinations of viscosity are being made on synthetic melts in the system lime-silica-iron oxide near the lime-silica boundary. An inclined plane viscometer has been developed.

6. The cause and control of abnormality in case-carburized steel. It has been shown that increase in abnormality is caused by the presence of dissolved iron oxide and certain alloying elements such as silicon and aluminum, and also by the rate at which the sample is cooled from the carburizing temperature.

7. Equilibrium of carbon and iron oxide in iron. A study is being made to determine whether the amount of iron oxide in steel is directly determined by the carbon content and the temperature. Preliminary results indicated that the amount of iron oxide present depends on how fast carbon elimination is proceeding.

Although the Bureau of Mines, through its technologic appropriations, has been able to spend about \$100,000 on these studies, yet, due to totally inadequate printing funds, it has been able to publish nothing regarding this work or the results obtained. Some outlet has been found via four preliminary publications through other organizations; it is a pity that none of this extremely important material can be published through regular Government channels and thus be made available in permanent and final form, to the steel metallurgists, furnace men, and chemists throughout the world.

Utilization of manganiferous iron ores.—Known domestic reserves of high-grade manganese ore are small, although there are considerable tonnages of low-grade material. Since manganese is necessary in steel, the development of processes to utilize the Nation's manganiferous iron ores as a source of ferromanganese assumes strategic importance. The Bureau of Mines has previously reported the successful production of manganiferous pig iron in the experimental blast furnace at its experiment station at Minneapolis, Minn. During the past year, it has studied methods for separating the iron and manganese in a one-half-ton experimental open-hearth furnace. A slag containing 45 to 50 per cent manganese has been consistently produced. The phosphorus and iron content has been adjusted by regulating the temperature and time of holding the slag under a coke layer. The chief difficulty comes in the viscosity of the slag so formed.

Control of gas-solid contact in the blast-furnace shaft.—The course of gas above the fusion zone in the blast furnace depends largely upon the distribution of the stock, which is in turn controlled by the method of charging. Results from a series of model experiments show that the average particle size at the center can be diminished

by increasing the rate of discharge from the big bell. This can be accomplished by a short stock line, steep bell angle, longer and faster bell drop, greater bell clearance, and proper proportioning of moisture. Charging ore before coke on the big bell also decreases the average particle size in the center of the furnace.

Transfer of heat from a gas stream to a column of irregular solids.—The efficiency of a number of industrial processes, such as the blast furnace, gas producer, and limekiln, depends upon proper transfer of heat from moving gases to colder solid particles. The transmission of heat from water flowing through a bed of steel balls of various sizes has been studied to give certain fundamental relations which can be applied to the other more complex systems on which study has just been started.

NONFERROUS METALLURGY

Fundamental metallurgical data.—Future progress in reduction metallurgy will depend in part upon more widespread use of precise thermodynamic methods. The chemist and chemical engineer have available fundamental scientific physical and chemical data, but in the past the metallurgist has lacked such information. In order to supply this lack, a comprehensive study is being made upon the generalized thermodynamic properties of oxides and sulphides. These studies are carried out by experimental investigations of reduction equilibria, free energies, specific heats from room temperature to that of liquid air, specific heats at high temperatures, and heats of formation and oxidation. During the past year, determinations of specific heats from room to liquid-air temperatures were completed upon the metals and oxides important in lead refining, including arsenic trioxide and pentoxide, antimony metal, antimony trioxide, tetroxide, and pentoxide, and bismuth trioxide. Measurements on metallic silicon were also completed. A series of determinations of the heats of solution of zinc oxide and pure zinc was carried out. The results obtained are of a degree of accuracy far superior to any previous figures. During the coming year the heats of formation of the oxides of copper, lead, and its associated metals; the specific heats at high temperatures of copper, lead, and associated metals; the specific heats at low temperatures of the oxides of the iron-nickel group and the sulphides of iron, manganese, and calcium; and the vapor pressures of the oxides important in lead refining, such as lead, antimony, arsenic, and bismuth, will be determined.

Mining and metallurgy of quicksilver.—Recent activity in the quicksilver industry has made it desirable to bring up to date the previous important bureau publications on this subject. The former study has now been extended to include information on the relationship of ore occurrence to mining, mining methods, prospecting and development, and economics.

The United States annually consumes about \$5,000,000 worth of mercury. Comprehensive data on the special channels of consumption for more than 90 per cent of the country's quicksilver have been obtained. Recent developments in the metallurgy of mercury have been studied and described.

Cyanide recovery of precious metals associated with minor amounts of copper and zinc.—The presence of soluble copper, even in amounts as small as 0.1 per cent, associated with precious metals in ore, has precluded cyanidation. In addition to the cyanide loss due to the presence of copper, the solutions are soon fouled if the usual zinc-dust precipitation is used. As the percentage of zinc in the cyanide solution increases, reuse of these solutions results in corresponding decrease in the extraction of the metals, principally silver. To assist in the cyanidation of this class of ores, the bureau's experiment station, at Reno, Nev., has worked out a process which is successful on ores containing up to 0.5 per cent cyanide-soluble copper. Eighty per cent of the cyanide combined with the copper is regenerated. Copper, zinc, and mercury are also saved.

Hydrometallurgy of manganese.—As part of the bureau program of research leading toward domestic independence in the production of manganese, the dissolution of this metal from its ores by the well-known sulphurous acid method has been further studied. The research will be extended by the investigation of the precipitation of manganese from sulphate solutions.

Tantalum and columbium.—As a result of an intermittent study of rare metals, an analytical procedure for the chemical determination of tantalum and columbium was devised and published.

Smelting in the lead blast furnace.—The Bureau of Mines during the past year has been studying the conditions within the lead blast furnace, and their influence on the metallurgical results obtained. Samples of the charge and gases were taken at various zones in the furnace, and their composition correlated with the conditions of operation of the furnace at that time. The results indicate several constructional weaknesses of the present furnace design. Other furnaces will be similarly studied.

Recovery of zinc from zinc ferrite.—In roasting zinc ores prior to leaching them, it has been found that the iron oxide in the calcine will combine with zinc oxide to form zinc ferrite, a compound insoluble in dilute sulphuric acid or ammonia. A method has been devised whereby the zinc may be made soluble and the iron insoluble in both reagents.

Microscopic investigations.—Microscopic studies during the year have continued to find the causes for mill-tailing losses where other methods of identification have failed. Frequently the difficulty lies in grinding, which may be too coarse to liberate the different minerals. Examination of an oxidized lead ore from Utah showed the presence of 4 per cent of molybdenum which was being lost by slagging in the smelting. Based on the microscopic analysis, a method was devised whereby the lead was volatilized and the residual iron and molybdenum in the calcine combined to form ferromolybdenum. Methods for the microscopic examination of minus 200-mesh slimes have been developed. A selective staining method applicable to oxidized lead minerals was developed and applied with considerable success.

Treatment of lead carbonate ores.—Lead carbonate ores occurring in many western mining districts are of too low a grade to be economically mined and shipped to the smelter, or else occur in districts unfortunately situated with respect to transportation facilities. The

concentration of these ores has consequently been studied and the results published in Technical Paper 413.

Reaction between magnetite and ferrous sulphide.—Sulphides in the charge of the copper reverberatory furnace reduce the magnetite with difficulty. As a result the magnetite tends to accumulate or pass off unchanged in the slag. Mechanical operating difficulties result if the magnetite accumulates; copper losses in the slag are high if magnetite passes off unchanged. A study of the reactions between magnetite and ferrous sulphide has shown that the reaction forms ferrous oxide and sulphur dioxide, although increasing the proportion of sulphides increases the importance of the reactions whereby sulphur or sulphur trioxide is formed. Increase of temperature markedly increases the rate of reduction of magnetite. The rate can be greatly decreased by an increase over the melt of the partial pressure of the gases formed by the reaction. The presence of silica greatly increases the rate of reduction, magnesia to a lesser degree, while alumina and cuprous sulphide retard the reaction.

Recovery of copper from converter slag.—A study of the forms in which copper is lost in converter slag shows that if the molten slag be cooled slowly so that a crystalline structure will be developed, the slag will be easy to grind and the copper will be largely in the form of sulphide, in grains large enough to be freed by grinding through 150 mesh. Cleaning the slag by flotation is indicated as a technical possibility.

Solubility of copper minerals.—A study of the dissolution of the various oxide and sulphide copper minerals in solutions of sulphuric acid and iron salts is necessary, due to the increasing attention being given to the recovery of copper by the leaching of low-grade disseminated ores. During the past year the work on oxidized copper minerals was completed. It showed that approximately 100 per cent of the copper is soluble in one hour in sulphuric acid (less than 5 per cent) or acidulated ferric sulphate solution. In 1 or 2 per cent neutral ferric sulphate the dissolution is somewhat slower, but in every instance the minerals are decomposed in 24 hours or less. The mechanism of dissolution of bornite and chalcocite has been studied. The size of particle had practically no effect from 3 to 200 mesh. Tetrahedrite, tennantite, and enargite are attacked much slower than chalcocite or bornite.

Leaching of agglomerated finely divided material.—In the Southwest and elsewhere there are millions of tons of finely divided tailings from copper concentrators which can not be leached in place or in vats without agitation, as the tailings are impermeable to the passage of solutions. This material in places contains as much as 20 pounds of copper per ton, and if it could be cheaply made permeable to the passage of leach liquors a great recovery of copper now lost could be effected. Tests have shown that up to 35 per cent of minus 200-mesh material can be agglomerated with coarser material up to 4 mesh in size and successfully leached by the open-drainage method. Leaching a material containing 1 per cent of copper, two-thirds of which is oxidized, 80 per cent of the total copper can be obtained in 14 days. By recirculation of solutions, the copper content can be built up to meet tank-house requirements.

ORE DRESSING

Beneficiation of manganese ores.—Only a few of the hundreds of manganese prospects found in diverse localities throughout the United States are rich enough to be smelted directly. During the past year, over 100 samples of low-grade ore have been given a preliminary examination. The carbonate of manganese (rhodochrosite) has been successfully floated on a laboratory scale and awaits a commercial trial. A slightly different procedure has been shown to be applicable to the oxide psilomelane. Roasting and magnetic separation have been successful on certain of the oxidized ores. If the insoluble matter is removed by gravity concentration, and if the limonite grains are not too badly locked with the manganese oxide, magnetic separation after roasting gives excellent results.

Ball and rod-mill grinding.—A series of experiments in five laboratory mills 18 to 42 inches in diameter using balls 1.25 inches in size showed that, in terms of power expended within the shell, the smallest mill was as efficient as the larger ones. A study of the trajectories of cataracting balls led to the development of a new equation describing the ball paths. The present parabolic equation was shown to be unsatisfactory due to the tendency for the balls to push each other until they reach the top of their path, thus preventing free upward flight. The old power formula was proven incorrect and a substitute devised. It was likewise shown that the smallest balls cataract from the liners while the largest balls loaf in the center of the mill. This throws the burden of grinding on the small balls and emphasizes the need to frequently replace worn balls.

In another set-up, equipped with an accurate device for measuring power input at the mill, independent of belt slippage, transmission losses, or motor efficiency, determinations are being made on the most economical use of power, the maximum power capable of being transmitted to the grinding media, and the causes of charge slippage in the mill. During the coming year, the effect of total grinding efficiency, useful grinding efficiency, and ball wear will be studied. An application to plant conditions of the fundamental crushing and grinding principles developed and reported last year showed that, at the plant studied, about 45 per cent of the power input to the motor was utilized in grinding, that 90 per cent of this was used in producing material finer than necessary, and that therefore the useful efficiency of the mills was about 4 per cent.

Improvements in milling southeast Missouri lead ores.—The milling practice of the Missouri lead district includes both gravity concentration and flotation. By close cooperation with the operators, operations have been improved so that less of the lead and zinc is lost. A factor in this progress is the introduction of classification before tabling. Five of the six operating mills in the district now have classifiers, designed to suit their particular requirements, feeding all their tables. These mills were formerly each day grinding 20,000 tons of ore through 14 mesh. Since the installation of the classifiers, a coarser feed is put on the tables, and the classifiers and tables do the sizing formerly done by five screens; the coarse table cuts only are returned to the ball mills, in place of the former practice of grinding all screen oversize. The expense of

fine screening is avoided, more coarse lead is recovered, and yet the ultimate grinding is finer than formerly. This change has facilitated the recovery of the small amount of zinc in the ore, so that now half the mills have differential zinc-flotation circuits in operation.

Improvement in milling practice of tri-State (Missouri-Kansas-Oklahoma) zinc district.—Some of the ores of the tri-State zinc district are so disseminated that the only means of efficient milling is by all flotation. This requires fine grinding. Certain of the fundamental studies on ball milling were therefore undertaken. During the next year, the results of this research will be applied to the practice in this district. Some plants have experienced difficulty in flotation, which was thought to be due to the plating out of the copper from the copper sulphate flotation reagent by the metallic iron abraded from the balls in grinding. This was consequently thoroughly investigated. The tests showed that metallic iron has a deleterious effect in an acid circuit. In neutral or alkaline circuits, the ill effect is noticeable when the amount of metallic iron is equal to two or three times the amount probably present in mill circuits. In concentration, the use of the constriction plate, so successful in multiple-spigot classifiers in the lead region, has been extended to the tri-State district to replace the drag deslimmer at the head of the table room, and also to replace the crude cones at the head of the retreatment jigs.

Beneficiation of Alabama oolitic iron ores.—The iron ores of the Birmingham, Ala., district as now mined are rich enough to smelt without concentration. This supply, however, is limited, and consequently the Bureau of Mines has, at various times, studied the possible means of concentrating the lower-grade material. Unlike the northern iron ores, the richest part of the ores of the Birmingham district is the slime; that is, the hematite disintegrates more readily than the gangue. Disintegration was therefore accelerated by abrading the hematite from the oolitic quartz with rubber-covered rods in a rod mill. The iron was recovered partly by desliming and partly by tabling.

Beneficiation of low-grade bauxite.—Studies of samples of low-grade bauxite from the Southeastern States of Alabama, Georgia, Tennessee, and Mississippi showed that a flotation process using sodium sulphide and oleic acid yielded fair results on high-silica ores, in which the principal contaminants were clay and free silica which were not too soft and claylike and in which the contaminants were not too badly disseminated. Some of the high-iron bauxites can be considerably improved in grade by gravity-concentration methods, although the iron minerals are frequently so disseminated that the elimination of much iron would be extremely difficult.

Beneficiation of low-grade phosphate ores.—In the land-pebble district of Florida the recovery of phosphate rock from the ores is effected by a simple washing and screening operation. Losses, however, are high and probably average nearly 50 per cent of the phosphate in the ores. During the last two years, studies of samples of washer rejects from the phosphate district have shown that additional recovery of commercial phosphate rock can be effected by more complete screening, either in present washers or in auxiliary plants yielding 10 to 30 per cent increased yields. Changes in washing

practice suggested by this work are now being put into effect by operators. Laboratory experiments indicate that gravity concentration may have some application to the treatment of phosphatic sands now discarded as waste. Flotation was applied successfully to samples of sands (minus 20 mesh) without preliminary grinding. Recoveries of from 85 to 95 per cent were obtained on sands ground to pass 48 mesh. Reagent costs are from 10 to 16 cents per ton of material treated.

Flotation fundamentals.—The Bureau of Mines is engaged in a comprehensive study of the floatability of pure minerals. During the past year, work on sphalerite was completed, and progress was made with certain nonmetallies, such as feldspar and mica.

Coal-washing investigations.—There are more coal-washing plants in Alabama than in any other State. The efficiency with which these plants are operated influences very materially not only the prosperity of the coal-mining companies, but also the conservation of the raw materials of the State. A study has therefore been made of methods of reducing to a minimum coal loss in the refuse, and, at the same time of securing a high quality of product. Detailed washability studies have been made of the Mary Lee seam in the Warrior field, and the Clark seam in the Cahaba field. These studies show to what ash content the coal can be washed economically, and what the recoveries of washed coal should be at various ash contents. This has set a standard toward which operators can work. It has also shown the types and proportions of impurities present, whether bone, rash, shale, or sulphur, and in so doing has thrown light on the proper steps for improving the process. Experimental work at one plant operating in the Mary Lee seam showed ways in which the ash in the washed coal could be decreased from 12 to 9 per cent (suitable for coke) by minor changes in the jigs.

Similar studies are carried on in the State of Washington. The results of experiments reported last year on the classification of the feed to coal-washing tables have led at least one plant to install a classifier to retreat table middlings, thus effecting a decrease in refuse coal and an increase in efficiency. Experiments on the distribution of particles of various shapes and sizes on coal-washing tables showed that the percentage of cubical particles in a given zone decreases with increase in the specific gravity of its components. That the coal, bone, and refuse particles discharged in the zones nearest the head-motion end of the table are more cubical than those discharged in succeeding zones, and that the coal found in table middlings consists mainly of flaky particles. Another study made at Seattle indicated that uniform distribution of the feed over the surface of the deck is important to good table practice, but that there is possibly a wide range in distribution without materially affecting the efficiency of the separation at practicable yields of washed coal. The capacity of the table and its efficiency, however, are substantially bettered by increasing the energy supplied by the head motion; that is, by lengthening the stroke and increasing the number of strokes per minute.

NONMETALLIC MINERALS

Extraction of potash from its minerals.—Polyhalite is the most important potash-bearing mineral found in the drilling of the Government test wells in the Southwest. This mineral is relatively insoluble, so that none of the European methods of potash extraction can be used. During the past year tentative methods for its treatment have been devised on a laboratory scale. Polyhalite is calcined at about 760° F., followed by quenching in two parts of boiling water to one part of mineral. Upon agitation for one hour at 100° C. and subsequent filtration, over 90 per cent of the potash is obtained in a 10 per cent solution. Two methods of subsequent treatment show promise. During the coming year the process will be applied on pilot-plant scale, if sufficient raw material can be obtained. Similar studies, recently authorized, on leucite, alunite, etc., will likewise be active. The large quantity of potash-bearing greensand marl of New Jersey has always attracted the chemical engineer because of its availability; many processes for utilizing this greensand have been proposed. During the year, the digestion of greensands with slaked lime under pressure at 200° to 240° C. was investigated in a 1-gallon autoclave. The results warrant extension of the study to a 100-gallon scale. An economic study was made of available processes showing the cost of raw materials, selling prices of products, freight rates to points of consumption, and the spread into which actual operating costs must be fitted. The latter costs are now being estimated. Studies on the extraction of potash from the concentrator tailings (6 per cent potash) of a western mining company treating a porphyritic copper ore, showed the possibility of converting over 90 per cent of its potash content into water-soluble form. The resulting product contained over 90 per cent potassium chloride. In order to aid in laboratory and economic studies of potash, both by the bureau and private interests, an extensive bibliography and abstract of all the foreign literature on the occurrence, mining, preparation, and refining of the foreign soluble salts was completed, but lack of printing funds prevents its publication. A similar work on greensand is nearing completion.

Application of the wire saw to slate quarrying.—Last year it was reported that wire-saw equipment, purchased by several operating companies after experimentation by the Bureau of Mines, was greatly reducing the waste in slate quarrying. The use of the equipment has spread rapidly until at the last report 20 operating companies now cut their slate by this method. At least 30 such saws are in use.

Preparation and uses of ochers and siennas of the United States.—So much interest was raised by a study of the ochers and siennas of the Pacific Northwest, reported last year, that the investigation has been extended to cover the entire United States. About 55 samples have so far been collected in 11 States through the cooperation of the State geological surveys.

Dewatering of kaolin and ocher suspensions.—The various methods for dewatering kaolin and ocher suspensions are being studied at the Seattle experiment station of the Bureau of Mines. During the past year an apparatus for dewatering by electrophoresis was built.

The most satisfactory test run with this equipment gave a reduction of 50 per cent in water content.

Bleaching of Pacific Northwest kaolins.—Results of studies on the bleaching of the kaolins of the Pacific Northwest show that the application of certain methods will decolorize the iron and carbon stained materials and allow their use for paper fillers. The work is being continued.

PETROLEUM AND NATURAL-GAS DIVISION

The rapid growth of the petroleum and natural-gas industries may be attributed in large measure to the detailed and painstaking studies which have been made of engineering principles involved in drilling and production, transportation, manufacture, and utilization of petroleum, natural gas, and their products. However, only through continued progress in petroleum technology will it be possible to recover additional percentages of oil held in partly depleted sands, and to obtain maximum recovery of lubricants and motor fuels from the crude oils. It is generally conceded that there are at least five major ways to extend the life of the petroleum reserves of the United States. These are the discovery of new sources of supply; new or improved methods of production whereby more than 20 per cent of the oil in reservoir sands can be recovered; new methods and processes by which a barrel of oil will be made to yield better products in larger amounts; methods and processes whereby motor fuels can be obtained by synthetic methods; and more efficient utilization of petroleum, natural gas, and their products.

The Bureau of Mines, since its inception, has been identified with the technologic research of the petroleum and natural-gas industries. During the past 15 years it has issued more than 450 publications pertaining to petroleum, natural gas, and allied substances. The problems under study by the petroleum and natural-gas division have direct bearing on all of the oil-producing and refining operations of the United States. The objective of the bureau's technologic research on petroleum and natural-gas problems is directed toward preventing accidents, eliminating waste, promoting economic methods of controlling production, and determining better and more efficient methods of manufacturing and utilizing products, with the view of conserving petroleum and natural gas—irreplaceable resources, essential in time of peace and invaluable in time of war.

DRILLING AND PRODUCTION PROBLEMS

Increasing the recovery from oil sands.—One of the major problems under study at the Petroleum Experiment Station of the bureau at Bartlesville, Okla., is the determination of methods for increasing the recovery of oil from sands. This problem involves fundamental research to obtain data regarding the physical characteristics of oil deposits and the physical and chemical properties of oil and gas in the sands, before and after partial depletion of the original fluid content of the reservoir; the flow of oil and gas through the pore spaces in the sands; methods of injecting repressuring media; and the control of the flow of oil and gas to maintain efficient and economical production.

With the aid of an experimental oil-recovery laboratory, four correlated problems are now under intensive study: (1) The determination of percentage depletion under ordinary methods of production, and the increased recovery which may be obtained by repressuring and by pressure maintenance; (2) the relative efficiencies of air, natural gas, and other repressuring media in the recovery of oil from sands; (3) the underground alteration of gases and other factors which effect changes in the physical and chemical properties of the oil where repressuring methods are used; and (4) the diffusion of natural gas and air in oil.

Air and gas at pressures varying from 25 to 800 pounds have been injected into flow tubes packed with oil-saturated sand. Production was obtained through openings or experimental wells of different diameters. In general, the larger-size orifices gave the most efficient and the greatest ultimate recovery. The results of the first series of tests have been published as a preliminary paper, *Oil Recovery Investigations of the Petroleum Experiment Stations of the Bureau of Mines*. A laboratory method was evolved whereby the initial pressure of the reservoir gave the basis for estimating the total recoverable oil by repressuring. This initial-pressure method gives promise of practical application in the field. Other series of tests have been made in order to determine what percentage of recovery can be obtained under different conditions of operation.

One series of tests was completed, which showed that as gas is dissolved in oil, the volume and A. P. I. gravity of the oil increase. The converse of this phenomenon is also true. The results of this study were published as a report, *Volumetric and A. P. I. Gravity Changes Due to the Solution of Gas in Crude Oil*. Another investigation relates to the use of propane as a repressuring medium. Preliminary results, obtained under conditions of constant input pressure and input volume, indicate that it is not entirely the solubility effect of the repressuring medium making the oil less viscous which influences the recovery of oil, but also the density and viscosity of the repressuring medium itself.

In studying the changes in the physical and chemical properties of oil, air has been recycled through an oil-saturated sand for a period of more than 800 hours. The oxygen content of the air was reduced about one-third, but only traces of carbon monoxide and carbon dioxide were found in the system.

The experimental data on oil recovery are being correlated with field studies. One report has been completed on the use of air to increase the recovery of oil in the Williams pool, Tex.; this is a shallow pool where repressuring methods have been applied for more for than two years. Appreciable increases in production were noted only after input wells were drilled for the express purpose of supplying air to the producing sand. The estimated gain in the production of this pool for one year, after a preliminary experimental period of six months, was 32 per cent.

Conservation of gas in the production of oil.—During the year, an outstanding contribution was made to petroleum engineering literature by the publication of a report made in cooperation with the American Petroleum Institute. This treatise of 267 printed pages, *The Function of Natural Gas in the Production of Oil*, deals with

the problems involved in the conservation of natural gas and its relation to economical oil production, a subject which has attracted the attention of engineers and operators throughout the industry. The data presented on development programs, the evils of competitive drilling, the effects of shutting in production, and the application of gas injection processes and gas storage, should serve as a guide to further studies relating to pressure control; production of oil in accordance with well-known engineering principles insures that the greatest amount of work is performed by the gas dissolved in and associated with the oil, in bringing oil to the wells and raising it to the surface.

Studies have been made in the Rocky Mountain fields in order to determine the thermodynamic efficiency of wells, and to find a relation between this efficiency and the amount of gas being produced with the oil. With the use of curves, it has been possible to determine the number of footpounds of work performed by the gas in raising oil to the surface. A method has also been developed for obtaining the thermodynamic characteristics of the expanding gas. The study of hole-bottom pressures is being made to determine in an accurate manner the relationship between the pressures in the sand at the bottom of a well and the flowing pressures at the wellhead.

At the Bartlesville station progress has been made in the study of the air-gas lift. A preliminary report, *Natural-Flow and Gas-Lift Experiments and Apparatus*, has been issued, describing the experimental equipment whereby oil will be raised from a large pressure reservoir representing the producing horizon, to the top of an 88-foot derrick. The tank has been packed with sand and saturated with gas-saturated oil. Data obtained by producing oil under accurately controlled conditions of natural flow and air-gas lift can be correlated with field data to derive fundamental formulas and efficient methods of air-gas-lift operation.

Engineering field studies.—Within the past 10 years, 31 engineering reports relating to fields in the Rocky Mountains, Texas, Oklahoma, Louisiana, and Arkansas have been published. These field studies not only are of immediate benefit to the operators in connection with their drilling and production problems, but serve as a means of collecting data for permanent record and afford an opportunity for coordinating laboratory data with actual conditions in the field.

During the past year a detailed report has been made of the Seminole area; this area attracted world-wide attention because of its spectacular rise to prominence. At the height of its producing period, this field produced more oil per day than any other field for a similar period. Part of this large production is attributed to the air and gas lift methods of production which have become almost synonymous with producing operations of that field.

Particular attention also has been given to the drilling of deep holes in an effort to determine methods of preventing the drill from deviating from the vertical. In the Seminole field, it has been found that some wells after being corrected for deviation are at least 400 feet less in vertical depth than the drilling log would indicate. This condition has led to a revision of the plotted contours of many oil-producing horizons. This and many other phases of oil-

field operations, such as deep drilling, water control, corrosion, and methods of production have been studied and are discussed in the complete report of the Seminole area.

A field study was made of the Roberts-Settles pool, near Big Springs, Howard Co., Tex. The water problems encountered in the Roberts-Settles pool may be typical of shallow lime production in the Permian Basin fields of Texas. This large area holds promise of being one of the major sources of petroleum of the United States during the next several years. The present study was made at the direct request of operators in the field, and many data have been furnished the operators with reference to the source of water, its rate of migration up the dip of the structure, and methods of controlling its encroachment toward wells.

The gas-producing formations in the Cotton Valley field, Louisiana, have been studied in order to ascertain the nature and character of the subsurface conditions and their influence on methods of producing and developing deeper pay sands. A study of the cratering of gas wells in Richland Parish has been made in order to determine the reasons why these wells blow out, and to develop methods for prevention.

Application of vacuum to oil wells.—A bulletin, *The Effect of Vacuum on Oil Wells*, has been written. This report discusses the history and development of vacuum processes and types of vacuum equipment, the capacity and volumetric and mechanical efficiencies of vacuum pumps, and the analyses and results of the various vacuum experiments conducted in this country and in foreign countries. The results of this study indicate that although vacuum has been responsible for greatly increasing the ultimate production of oil in certain areas, in other fields where conditions were less favorable vacuum has been of little or no benefit. In view of newer methods of oil recovery, the application of vacuum is tending to become obsolete.

Paraffin deposits in oil wells.—Continuing the study of deposits of paraffin in oil wells by the Laramie (Wyo.) office, the investigation has been directed to obtain better and cheaper methods for removing paraffin from oil wells and methods of preventing its deposition. A study has been made to determine the action upon paraffin of different solvents and the degree of solubility of paraffin in petroleum ether, natural gasoline, kerosene, straw distillate, refined mineral oils, and crude oil. The plotted curves show that the solubility of wax or paraffin in hydrocarbon products increases as the solvent becomes lighter, until a point is reached where the solvent contains a large amount of butane and propane. Data have been obtained also on the melting point, index of refraction, molecular weight, and other properties of different wax fractions. It has been found that relatively large amounts of high-melting-point wax may be obtained from the paraffin deposits in oil wells. Where fields producing large quantities of paraffin are favorably situated, there are commercial possibilities in the collection and refining of this high-melting-point wax.

Evaporation losses.—The studies on evaporation losses of petroleum were continued during the year with particular reference to large storage tanks. More high-gravity crude oil has been stored in various types of large tanks during the past two years than ever before in the history of the petroleum industry. Tests made with par-

ticular reference to crude oil from the Seminole field confirmed previous recommendation of the bureau and proved conclusively the value of vapor-tight tanks.

Corrosion of oil tanks.—In cooperation with companies studying corrosion problems, a battery of test tanks has been under close observation in the Texas Panhandle field, in order to determine means of reducing the excessive corrosion of tanks used for handling sulphur-bearing oils. Thermocouples, gages, and other recording and sampling devices have been installed in the tanks in order to obtain definite information regarding the oil, the hydrogen sulphide, and corrosive waters produced with it, and the humidity, temperature, and character of the tank vapors. At definite intervals microscopic examination is made of test specimens of the tank material to determine the corrosive action within the tanks.

Disposal of oil-field waters.—A study has been made to determine economic methods for the disposal of oil-field waters and the possible extraction of certain rare salts. Special attention has been given to the possibility that traces of barium in certain waters may be responsible for the death of livestock. A report has been issued, *Methods of Disposal of Oil Field Waters*, in which are given results of tests on evaporation ponds, the restrictions placed upon allowing waste waters to flow into certain streams, and precautions which should be observed before attempting to return salt waters to underground reservoirs where, through migration or other causes, domestic water supplies may be contaminated and active or potential oil fields may be injured through water encroachment.

Salvages in the oil industry.—A study was made of the salvages of material and equipment used in the petroleum industry, in order to reduce loss through unnecessary scrapping. A report, *Material Salvages in the Oil Industry*, has been prepared from data collected in various oil fields throughout the United States.

Geophysical methods of prospecting for oil and gas.—Engineers of the Bureau of Mines have collected a large amount of data on geophysical prospecting methods used by oil companies in determining the existence of salt domes and other structural high points where oil in commercial quantities may be found. A report, *Geophysical Methods of Prospecting for Oil and Gas*, has been prepared, reviewing the factors governing the accumulation of petroleum, giving general information on methods of geophysical prospecting, explaining geophysical terms and units of measure, and citing typical examples of the application and relations of geophysical prospecting methods to the problems of applied oil-field geology. These examples include gravimetric methods—of which the torsion balance is probably the best known—magnetic, seismic, electrical, thermic, and radioactive methods. Study has been made of the organization and personnel of geophysical departments and the cost of geophysical equipment and operating expenses. A general discussion is also included, regarding the application and limitations of various geophysical prospecting methods and their economic aspects.

NATURAL GAS

Gas-measurement problems.—The study of the measurement of gas flow by means of orifice meters was continued through the year,

in cooperation with the natural gas division of the American Gas Association. The tests were conducted at higher pressures than were used in the tests of previous years, and considerable difficulty was experienced from leakage. Welded joints proved to be the best solution of this difficulty. Over 900 separate tests were made to determine factors which influence the measurement of gas, no final report can be made until the calculations have been completed and corrections applied.

Development of pipe-line-flow formulas.—Study of the flow of natural gas through pipe lines was continued, also in cooperation with the American Gas Association. This problem includes economic handling and transportation of natural gas from the wells to points of utilization; the design and construction of pipe lines; and the development of pipe-line-flow formulas. Field tests of gas-transmission lines were made in Texas, Oklahoma, Ohio, and West Virginia. A report, *The Flow of Natural Gas Through High-Pressure Transmission Lines*, gives comparisons of tests made on 25 operating pipe lines in these and other States. The results indicate that under constant-flow conditions, with no obstructions in the line, the measured rates of delivery compare more closely with the rates of delivery calculated from Weymouth's pipe-line-flow formula than with those calculated from any of the other pipe-line-flow formulas in common use. Other tests are in progress, to establish definitely the effect on the flow of gas through pipe lines of different diameters of pipe, types of joints, internal smoothness of pipe, and the velocity, viscosity, supercompressibility, and chemical composition of the gas.

Controlling and gaging natural-gas wells.—The study of open-flow capacities of gas wells has an important bearing on the conservation of natural gas. Open-flow tests not only waste millions of cubic feet of gas annually, but frequently injure wells and interfere with the orderly depletion of the gas content in the sand.

Two companion reports, *The Study of a Fundamental Basis for Controlling and Gaging Natural Gas Wells*, have been published. Part I gives a method for computing the pressure at the sand in a gas well; Part II applies this principle in determining a fundamental relation for gaging gas-well capacities. Additional tests are being made to determine accurate data on sand conditions, initial rock pressures, and the flow of gas through reservoir sands. This problem is directly related to those of estimating gas reserves, the storage of gas in depleted sands, the use of gas as an expulsive force for oil recovery, and other operating problems.

REFINING AND CHEMISTRY OF PETROLEUM

Study of crude petroleum.—Fundamental information relating to the physical and chemical characteristics of the crude oils produced in the various fields of the United States and foreign countries aids the refiner in selecting crude oils suitable to his processes and market requirements, and assists the producer in determining the inherent value of his product. Progress in this phase of research is reflected by the publication of the reports, *Studies in the Fractional Distillation of Crude Petroleum*, and *The Determination of Molecular*

Weights of Nonvolatile Petroleum Oils. Work was projected on a bulletin dealing with the chemistry of crude petroleum as shown by the Hempel analysis. The bureau's large collection of representative samples of crude oils has been greatly augmented. Special attention has been given to the collecting of samples of oils from the Eastern Hemisphere, and progress has been made on the laboratory analyses of these samples. Semicommercial refinery runs were made on a number of domestic crude oils. Reports published were *A Study of the Less Volatile Oils in Salt Creek (Wyo.) Crude Oil*, and *A Study of the Crude Oil Produced in the Salt Creek Field, Wyoming*. Work was continued on the study of crude oils from Cabin Creek, W. Va., Tonkawa, Okla., and Midway, Calif.

Treatment of light petroleum distillates.—A detailed study of methods for treating light petroleum distillates has been made in the laboratory and at refineries throughout the United States, in order to determine the objectionable constituents present in light petroleum distillates, and to ascertain adequate methods of removing them. It has been found that most of the undesirable compounds usually occur within a comparatively narrow boiling range. By removing those fractions which contain sulphur and other impurities during the distillation process, only a relatively small portion of the light distillate requires chemical treatment, resulting in a reduction of chemicals used and limiting the treatment losses to a small portion of the oil. A *Rapid Corrosion Test for Gasoline* has been published, and a report has been prepared on modern methods of chemical treatment and the effects of fractionation in reducing the amount of necessary treatment.

In order to observe the action within a fractionating tower, an apparatus was built and is described in a report, *A Visible Action Continuous Distillation Apparatus for Laboratory Study of Fractionation*. The shell of this tower is of pyrex glass, making it possible to definitely observe the action and to control the flow of the overhead, side, and bottom streams from the tower. The yields of these various streams can be varied at will to obtain products of definite boiling ranges. The separations are sharp and definite. Requests for construction drawings of this apparatus have been received from many refiners in this country and in foreign countries.

Lubricating-oil studies.—The service tests of lubricating oils in internal-combustion engines were completed at the San Francisco field office. A report, *A Study of the Relationship Between Volatility and Consumption of Lubricating Oils Used in Internal-Combustion Engines*, points out quite definitely that the engine consumption of naphthenic oils used in the tests was much less than had been generally supposed, and that all types of lubricating oils tested had about the same lubricating value.

At the completion of these tests, the refinery study at the San Francisco office has been directed to methods for removing asphalt and sulphur compounds from California crudes by fractional distillation, thereby making it possible to recover from these oils valuable lubricating constituents heretofore sold with the fuel oil and gas oil.

Separation of wax from wax distillates.—Although wax has been manufactured in about the same manner for many years, the present

investigation shows that the careful preparation of wax distillate, particularly with respect to color, simplifies the subsequent separation and refining of wax. Methods of handling wax distillates are being studied in order that the detrimental effects of amorphous wax can be minimized, thus making available additional quantities of crude oil for the manufacture of high-grade lubricating oils.

Sulphur compounds in crude petroleum.—Research was continued on the isolation and identification of the various types of sulphur compounds occurring in Inglewood (Calif.) crude oil. Progress was made in developing volumetric and other analytical methods for detecting and determining sulphur and sulphur compounds in petroleum. It was found that by brominating petroleum fractions some knowledge of the chemical structure of the oil could be obtained. Samples of west Texas crude have been studied also, and a number of preliminary tests were started on these crudes, which previously had been topped and dewaxed, to determine the relative value of acetone and other solvents in segregating sulphur compounds.

Synthesis of hydrocarbon motor fuels.—In order to develop a possible utilization for large quantities of natural gas which are unmarketable at present, the synthesis of the products of decomposition of natural gas into hydrocarbon motor fuels by means of heat, pressure, and other agencies has been studied throughout the year. Gas used in this research was obtained from the Poteau (Okla.) field. This gas contains about 97 per cent methane and no heavier hydrocarbons. It has been established that benzol can be obtained from methane in appreciable quantities, and the work at the Bartlesville station is being directed to determine the optimum conditions for the transformation of gas into liquid fuel through the decomposition of methane. About 50 runs have been made during the year to determine the effects of varying the rates of flow, the temperatures, and the experimental apparatus. The exit gases have been analyzed by one of three methods—in the usual Burrell absorption apparatus; in a vacuum-jacketed fractionating column; or in the Shepard-Porter apparatus designed for separation of gases by liquefaction. The last two methods utilize liquid nitrogen as a condensing agent and provide a means for the very exact analyses essential to this work. The presence of 5 to 7 per cent of unsaturates in the exit gas, mainly acetylene and ethylene, suggests that the yields of liquid products may be considerably increased by polymerization or hydrogenation of these unsaturates. The pyrolysis of methane is of fundamental importance in this study. It is proposed to expand this work into larger-scale experiments, to determine the commercial application of the synthetic methods evolved in the laboratory.

Motor-gasoline surveys.—During the past nine and a half years the bureau has made semiannual surveys of the gasoline marketed in the United States; for each survey approximately 160 samples are collected from 12 cities. These cities represent the more important marketing territories of the country, and give a cross section of the general character and quality of the gasoline in commercial use. Serials 2887 and 2916, reporting the eighteenth and nineteenth semi-annual motor gasoline surveys, indicate that there is a common tendency toward marketing a standardized product, as individual variations from the average are small.

OIL SHALE

Investigations regarding the mining and retorting of oil shale were continued at the experimental mine and the experimental oil-shale plant (on naval oil-shale reserves Nos. 1 and 3) near Rulison, Garfield County, Colo. This work is a continuation of that begun in 1925, when two retorts, one of Scottish and the other of American design, were erected at the plant site. The purpose of the work was to study problems connected with mining oil shale and retorting the shale in representative, but fundamentally different, types of retorts. During the past year, valuable information was obtained on the mining of oil shale, including some data as to costs of mining, the most effective spacing and depth of drill holes, and the best explosives to use. The retorting experiments included charging the retorts under various rates and conditions of throughput and temperature-control, to determine their effect on the quantity and quality of oil produced. It was demonstrated that the American type of retort in use at the plant will handle, under controlled conditions, almost any shale, whether rich or lean, coking or noncoking. The experimental oil-shale plant was closed on June 30, 1929. The data which have resulted from this experimental program should assist materially in answering many questions regarding the feasibility of an American oil-shale industry, and under what conditions of supply and demand it might be economical to produce shale-oil products in competition with other sources of liquid fuels and lubricants. During the year, two papers were published giving a preliminary review of the work accomplished at the experimental oil-shale plant, and a bulletin has been written giving the complete results of the experimental work in 1926 and 1927. Another bulletin is in preparation which will describe the work in 1928 and 1929.

Samples of the shale oil from the various runs of the retorts have been sent to the Boulder (Colo.) shale-oil laboratory, where tests have been made in an experimental refinery. The topped, crude shale oil was cracked at various pressures, to determine that pressure which will yield the highest percentage of motor fuel. Experiments were made to develop processes for treating the cracked distillates with concentrated sulphuric acid and other chemicals, in order to obtain motor fuels suitable for commercial use. Gasoline has been produced at Boulder which was white in color, stable in character, of good odor, and which conformed to Federal specifications for motor gasoline.

SAFETY IN THE PETROLEUM INDUSTRY

Safety problems in the petroleum industry were studied. Safeguarding, in the broader sense, is a matter of good judgment based upon experience and training and good engineering practice. First-aid training was extended, and in the Seminole (Okla.) field alone, 3,000 men completed the prescribed course in three and one-half months. Detailed instruction was given regarding the hazards of hydrogen sulphide poisoning in west Texas fields, and at many plants where high-sulphur crudes are refined. A report was written on Safety at Natural-Gasoline Plants. Other fire and explosion hazards, particularly with reference to repressuring operation, have been studied. In all of this safety work, the bureau has endeavored to

anticipate new hazards which may develop because of new conditions, methods, or processes. An advanced training course, covering the hazards and methods of protection against gases encountered in the petroleum industry, has been prepared; this report will be used as the basis of a safety manual. Other chapters dealing with various phases of accident-prevention work are in preparation.

BIBLIOGRAPHY OF PUBLICATIONS OF THE PETROLEUM INDUSTRY

Monthly bibliographies of recent articles relating to the petroleum and natural-gas industry were prepared. The references include abstracts on history and geographic occurrence; geology and origin; development and production; transportation, storage, and distribution; properties and their determination; refining and refineries; utilization; legislation and legal regulations; patents; and safety and fire prevention. As of January 1, 1929, cooperation with the American Petroleum Institute and the Special Libraries Association was arranged whereby the various libraries of the institute members abstract the literature of designated publications. This material is reviewed, assembled, augmented, and mimeographed by the bureau.

Although the bureau was able, up to and including 1923, to issue yearly reports covering the complete bibliography of oil literature, it has been unable to publish subsequent volumes of this useful work through the Government Printing Office, due to lack of printing funds. While a monthly mimeographed copy of current bibliography has been regularly issued, its ephemeral form makes it useless for permanent record and for library reference work. It is desirable, from every point of view, to bring this series to date through publication, but there appears to be no immediate prospect of funds for this purpose.

EXPERIMENT STATIONS DIVISION

The experiment stations division coordinates the work of the 11 experiment stations at which the technologic studies of the bureau are mainly conducted. These stations give particular attention to the solution of problems affecting the mineral industries of the regions in which they are situated. The problems being studied at the various experiment stations are outlined in this report under heading indicating the work of the different divisions of the bureau.

Work of the different stations.—The Central Experiment Station, at Pittsburgh, Pa., is by far the largest of the 11 stations. At this station, the problems studied are chiefly those relating to coal mining, the utilization of coal and coal products, the health of workers in the mineral and allied industries, the technology and safety of explosives and electrical mine equipment, and the metallurgy of iron and steel. This station has supervision over the Experimental mine at Bruceton, Pa., 14 miles away, which is operated exclusively for the purpose of scientific research.

The Petroleum Experiment Station, at Bartlesville, Okla., is the largest research plant in the world exclusively devoted to the study of problems affecting the production and refining of petroleum and the utilization and conservation of petroleum and natural gas.

The Southern Experiment Station, at Birmingham, Ala., gives particular attention to the problems of the coal, iron, and non-metallic industries of the Southern States.

The Nonmetallic Minerals Experiment Station, at New Brunswick, N. J., conducts inquiries into the mining, treatment, and use of the numerous important nonmetallic mineral products. At present, efforts are being concentrated on the development of methods for the utilization of polyhalite, greensand, leucite, alunite, etc., as sources of potash.

The North Central Experiment Station, at Minneapolis, Minn., works on problems connected with the beneficiation and smelting of manganiferous iron ores of the Lake Superior region, and with the study of fundamental blast-furnace reactions.

The Mississippi Valley Experiment Station, at Rolla, Mo., seeks to prevent waste and to increase efficiency in the important lead and zinc industries of the Mississippi Valley. It likewise serves as a center for the bureau's ore-dressing studies.

The Intermountain Experiment Station, at Salt Lake City, Utah, studies the treatment of the complex low-grade ores whose development affects the progress of the region. The station gives attention to the study of the flotation process in metallurgy.

The Northwest Experiment Station, at Seattle, Wash., investigates the mining problems and the utilization of the coals and nonmetallic minerals of the Pacific Northwest and Alaska.

The Pacific Experiment Station, at Berkeley, Calif., conducts highly specialized research concerned chiefly with the determination of metallurgical constants.

The Rare and Precious Metals Experiment Station, at Reno, Nev., carries on research on the rare and precious metals.

The Southwest Experiment Station, at Tucson, Ariz., is concerned with the mining and metallurgical problems of the Southwest, especially those affecting the mining and treatment of low-grade copper ores.

HELIUM DIVISION

Helium, the rare noninflammable gas found in quantity only in the natural gases of a few fields, is essential for the safe operation of dirigibles. Many disasters involving lighter-than-air craft would have been prevented if the lifting gas used had been nonburning, non-explosive helium instead of highly inflammable hydrogen. The maintenance of a sure and cheap supply of helium is therefore an urgent military necessity. Helium was formerly so extremely expensive that it was available only for laboratory experimentation; the first helium bought by the Federal Government, not many years ago, is reported to have cost \$1,600 per cubic foot. As a result of investigations made by the Bureau of Mines, methods have been devised which have reduced production costs for helium to a small fraction of the former expense, thus rendering it available for the military needs of the Nation; the most recent manufacturing costs attained by the Bureau of Mines at its new plant, near Amarillo, Tex., are much lower than have heretofore been attained by anyone in the world; the military services are now able to purchase their helium from the bureau plant at about 2 cents per cubic foot, and when the new plant is running at the full capacity of the two units, these costs should not exceed $1\frac{1}{2}$ cents per cubic foot.

The Congress transferred all Government helium activities to the Bureau of Mines, and has yearly instructed the bureau to proceed with the comprehensive program of conversion, development, and production of an adequate helium supply. The final program was outlined about two and one-half years ago, and estimates were given by the bureau as to the length of time and amount of money required to carry through the program, and the results that might be expected as to production cost and quantity produced. It is gratifying to note that the bureau's estimates as to time and money required have never been exceeded at any of the stages of the program, and that the expectation of the bureau as to production rates and costs have been fully realized.

Helium production.—Helium production was carried on during this fiscal year in the United States Bureau of Mines helium production plant No. 1, near Fort Worth, Tex., and at the new United States Bureau of Mines Amarillo helium plant, at Soncy, near Amarillo, Tex. The Fort Worth plant, constructed under cognizance of the Navy Department, in 1921, was placed under the complete jurisdiction of the Bureau of Mines by legislative enactment July 1, 1925. It was closed permanently on January 10, 1929, owing to depletion of the Petrolia gas field, the sole source of its supply of helium-bearing natural gas. The Petrolia gas field was old when the Fort Worth plant was built, but it was at that time the only known resource of helium-bearing gas large enough in quantity and rich enough in helium to permit of consideration for large-scale helium production.

Ever since the inception and initiation of the Government's helium project by the Bureau of Mines in 1917 it has been conducting an exhaustive geologic and engineering field survey for the discovery and estimation of sources of supply of helium-bearing natural gas. It was thereby developed that a gas of exceptional richness in helium was to be secured in the Cliffside structure of the Amarillo gas field, located a few miles to the north and west of Amarillo, in Potter County, Tex., and it is confidently believed that in this structure there is contained a supply of helium-bearing gas sufficient for Government needs for many years to come. Four gas wells drilled on this structure substantiate the correctness of this view. Two of these wells were drilled under the supervision of the Bureau of Mines, one of them during the past year. In consequence measures were taken by the bureau to secure the gas rights to lands on the Cliffside structure. Gas leaseholds on approximately 26,000 acres of land covering a considerable part of the structure are now under the bureau's control. A plant site of approximately 18½ acres of ground was acquired adjacent to the town of Soncy, approximately 7 miles due west of the center of the city of Amarillo, favorably located on the line of the Rock Island Railroad and the United States Highway No. 66, and during the past year a helium-production plant has been erected and one unit of the plant has been installed and put in operation on that site. Also an 11-mile gas pipe line and gathering lines, connecting the wells on the Cliffside structure with the plant, were completed under bureau supervision. A line to convey gas, after processing, from the plant to commercial consumers

at Amarillo has also been constructed. The helium-separation apparatus so far installed in the plant is the equipment and apparatus of the former so-called production plant No. 2 designed and erected entirely by bureau engineers and given experimental production trials at Fort Worth. This unit, materially modified during the past year by engineers of this division, was disassembled, shipped to Soncy, and, with certain supplementary additions, there erected. The first tank car of helium, containing approximately 185,000 cubic feet, produced by this plant, left Soncy for the Army air station at Langley Field, Va., May 6, 1929. A second and somewhat improved unit for the Soncy plant has been designed within this division, and its construction is under way.

Cryogenic research laboratory.—The cryogenic research laboratory, used for the purpose of developing experimental data essential to helium production, and purification after use, was removed from the bureau's Pittsburgh Experiment Station to the Soncy plant early in 1929 and installed in a building specially erected for its purposes. The intricate and delicate scientific research apparatus was in the final process of assembly at the close of the year. The work of the laboratory, as now conducted at the Soncy plant, includes, besides strictly cryogenic research, the performance of all control analyses pertaining to the production plant and its allied facilities, as well as those relating to the bureau's gas-field investigations, which comprehend examinations of samples of natural gas for helium content and other constituents, obtained from various fields throughout the country. Although its research program was interrupted during the year by the move from Pittsburgh, several problems, such as solubility of helium in liquefied mixtures of certain natural gases, and the determination of liquid-vapor compositions for nitrogen-methane mixtures and methane-ethane mixtures, were studied, and a research having for its purpose determination of the specific heats of liquefied methane, ethane, and nitrogen, of extreme importance to helium production and kindred work employing gas liquefaction, was completed and the results will be published during the coming year.

Resources and supplies of helium-bearing natural gas.—Work conducted under this general heading during the year embraced several field activities. Gas-engineering activities pertaining to the Cliff-side structure included engineering and supervision of gas-well drilling; maintenance and regulation of producing wells, of gas meters, and control equipment; and engineering supervision of construction of gas transportation facilities, including main and gathering pipe lines. The work of gathering and correlating as completely as possible data concerning the location and extent of helium resources of the United States was carried on, as in former years, many samples of gas from various places throughout the country being acquired and examined for helium and other constituents. Engineering studies were made of gas-producing areas and contacts were maintained with operators.

EXPLOSIVES DIVISION

One of the many hazards confronting miners is the necessity of handling and using high explosives. Approximately 80 per cent of

the total quantity of explosives sold and used in the United States is consumed by the mining and quarrying industries. The petroleum industry also uses large quantities of nitroglycerin at oil and gas wells.

The explosives division of the Bureau of Mines tests explosives to determine their suitability for use in gassy or dusty coal mines, studies the ingredients of explosives, and investigates the methods of handling, using, and storing explosives in mining operations.

One of the greatest factors in the campaign for preventing accidents in coal mines is the group of "permissible" explosives developed under the guidance of the Bureau of Mines; these are far safer than other types of explosives. "Permissible" explosives are explosives that are similar in all respects to samples that have passed certain scheduled tests of the Bureau of Mines, which tests have been designed to ascertain the safety of such explosives for use in mining coal. They are "permissible" for use in blasting coal only when they are used in the quantity and manner prescribed by the bureau. In contrast to the long, lingering, intensely hot flame emitted by black powder, a permissible explosive produces a short, comparatively cool flame which is of brief duration and is not nearly so likely to ignite dangerous accumulations of gas and coal dust.

Publication of active list of "permissible" explosives.—Perhaps the most important work of the explosives division is testing "permissible" explosives, developed under the guidance of the Bureau of Mines. Lists are published monthly of the explosives which have passed the bureau's tests for permissibility, and at the end of each fiscal year a complete list of all active "permissible" explosives is published. On June 30, 1929, there were 130 explosives on this list and 1 permissible blasting device.

"Permissible" blasting devices.—To foster the development of the safest possible methods of bringing down coal, Schedule 20, under which blasting devices may be tested, was issued. The term "blasting device" includes (1) all devices for breaking down coal, except devices where operation is wholly mechanical and obviously presents no explosive hazard; and (2) explosives of the "permissible" type which are tested under Schedule 17A. A new blasting device was tested and approved during the year; this novel device employs as the blasting agent liquid carbon dioxide confined in a steel shell. A heating element centrally disposed in the shell is ignited electrically by a single-shot "permissible" firing battery, and the heat produced gasifies the carbon dioxide, thereby producing sufficient pressure to shear a steel disk at the end of the cartridge. The force of the released gas brings down the coal.

Propulsive strength of explosives.—As part of an investigation of the factors that contribute to the effectiveness of dynamite in blasting rock, the propulsive strength of all the commercial blasting explosives has been measured by means of the ballistic pendulum. A method of rating the relative strength of the various explosives on the basis of 100 per cent blasting gelatin has been devised. This is more rational than the present method, which rates an explosive according to the grade of straight nitroglycerin dynamite to which it most nearly corresponds in propulsive strength.

Low-freezing dynamites.—The thawing of frozen dynamites was at one time a hazardous duty which fell to the lot of every user

of explosives during the winter; this hazard has now been eliminated by the development of low-freezing dynamites. Recent work by the bureau has shown that the low-freezing dynamites are equally efficient as to propulsive strength, rate of detonation, and sensitiveness, and that low-freezing explosives of the "permissible" type are equally safe for use in coal mines. The majority of "permissible" explosives are now low-freezing.

Review of permissibility test data.—As a result of tests of explosives for permissibility during the past 20 years, a considerable amount of valuable data has been accumulated. During the past year, a review has been made of the experimental data which relate to the liability of various types of explosives to cause ignitions in coal mines of inflammable gas or coal-dust mixtures with air. The tabulations indicate statistically the approximate charge limit or order of safety for a group of explosives of similar chemical composition, and also indicate the effect of flame-cooling agents such as sodium chloride. Explosives containing no flame-cooling agents showed 75 per cent failures, while those containing 10 per cent sodium chloride showed only 5 per cent failures. The addition of various low-freezing ingredients has been found to be without deleterious effect on the safety of coal-mine explosives.

Photographing gas and dust explosions.—In developing new and safer explosives for use in coal mines, more knowledge is needed as to the mechanism of ignition of inflammable gas and dust mixtures by the firing of explosives used in mining. Work has been continued with a specially designed gallery and high-speed cinematographic apparatus which records the details of the ignition process photographically. It has been shown that the pressure-wave produced by the shot is a contributing factor in bringing about ignition. Mixtures of gas and air which are noninflammable when exposed to ordinary flames will burn momentarily under the influence of the tremendous pressure wave sent out by an explosive.

Fumes produced in blasting.—Dynamite used in underground blasting must produce the least possible amount of poisonous fumes in order that the hazard of asphyxiating workers at the face may be reduced to a minimum. In order to develop a dynamite which best satisfies this requirement, experimental blasting tests with a series of specially prepared dynamites of varying chemical composition have been conducted in cooperation with one of the large powder companies. Analyses of the mine atmosphere after the blast have made it possible to determine under practical conditions the formula which gives the least amount of toxic gases. The results have been compared with data obtained in various types of laboratory apparatus in order that for future work the apparatus which best simulates field conditions may be employed.

Photographing invisible waves.—Since, as above stated, it is believed that the pressure wave produced by a blast is a contributing factor in bringing about the ignition of fire damp in a mine, a photographic method has been developed at the bureau's explosive testing laboratory for obtaining a record of the pressure wave, from the moment the flame of an explosive leaves the cannon in which it is fired, to the time at which the flame of the burning gas-mixture emerges from the gallery containing this mixture. These pressure waves, normally invisible, are rendered visible by an optical ar-

rangement which is known as the Schlieren method, and are then photographed by Payman's wave-speed camera. This method gives promise of providing a valuable and graphic method of determining the relative safety of explosives when fired in the presence of fire-damp or coal-dust-air mixtures. The information thus obtained will be of value in the development of safer explosives for use in coal mines.

Temperature of flames.—Direct measurements of the temperature of gas flames and of the flames produced by explosives are needed in connection with studies of gas explosions in mines and other industrial operations, and the mechanism of ignition of fire-damp air mixtures by the explosives used in mining. Work has been concentrated this year on measurement of stationary gas flames and the method of sodium-line reversal was finally adopted as most reliable. Using this method, the temperatures of the flames of methane and a number of other combustible gases burning in air have been measured. Preliminary work on explosive flames, using a specially designed resistance thermometer, has given results which serve to differentiate between safe and dangerous explosives, but are not sufficiently reproducible to detect smaller gradations of safety. The attempt will next be made to use one of the methods being developed for measuring the temperatures of stationary flames.

Inflammability of gases and vapors.—New compounds are frequently being introduced into industry for use as anæsthetics, refrigerants, fumigants, insecticides, and solvents. In order that these materials may be used safely, it is necessary to know the fire and explosion hazards attending their use. The bureau's flame laboratory has determined the inflammable limits of a large number of such compounds, including ethylene, ethyl ether, ethylene dichloride, ethylene oxide, vinyl chloride, carbon disulphide, pentane, benzol, acetone, furfural, and ethyl alcohol. Measurements are being continued on other inflammable materials used in industry or which have been suggested as having industrial application.

Shock waves.—Pressure-wave photography has been employed to investigate the sensitivity of explosives in detonation by influence. When a cartridge of dynamite is separated from another by an air gap, and detonation is initiated in the first cartridge, the second cartridge is caused to explode by influence providing the gap is not too great, and the second cartridge is sufficiently sensitive. It is the nature of this influence which is being investigated by pressure-wave photography, using a high-speed camera in which the film moves at 70 meters per second. The photographs show that the first cartridge sends out pressure waves which beat against the second cartridge and that an instant later the expanding gases from the explosion strike the second cartridge. Sensitive explosives may be detonated by the pressure waves, while less sensitive explosives do not detonate until struck by the body of hot expanding gases. The method will be used also to investigate the mechanism of the ignition of fire-damp air mixtures by the explosives used for blasting in coal mines, where it is believed that adiabatic compression of the inflammable mixture may play a part in causing explosions.

OFFICE OF CHIEF MINING ENGINEER

The work of the chief mining engineer, who reports directly to the director of the bureau, comes under four heads: Chairmanship of the mine-safety board; investigations at the Experimental mine; cooperation with the British Government in mine-safety research; and special studies.

Mine-Safety Board.—This board, consisting of the heads of certain technical divisions, was established in 1924 to consider questions arising within any divisions of the bureau that require a definition of the bureau's collective opinion as to safety practices, safety devices, or safety methods for underground operations or open-pit mining. Such decisions, which take the form of recommendations, when approved by the director form the basis of teaching and policy for the bureau.

During the past year recommendatory decisions were made on the number and arrangement of escapeways from mines; ventilation of haulage and hoisting ways; and methods of charging and firing shots with permissible explosives or permissible devices. All these were approved by the director and were then made public. While the decisions are primarily for the information of members of the bureau's mine safety staff, a circular embodying the recommendations of the board on certain questions of mine safety was given general distribution during the year. This publication is now being revised to embrace later recommendations.

Cooperative work with British Safety in Mines Research Board.—The interchange of technical information between the staffs of the United States Bureau of Mines and the British Safety in Mines Research Board continued in a satisfactory manner. During the year the chief engineer of the staff of the Safety in Mines Research Board visited the Pittsburgh Experiment Station and certain typical coal mines in the study of mechanized mining. An explosives expert was also detailed for a period to Pittsburgh to introduce the new Schlieren method of testing explosives which had been successfully used in Great Britain. After his return to Great Britain, another explosives engineer was detailed from that country for a year to carry on this research work.

In exchange, the Bureau of Mines detailed a gas-mask expert to the Sheffield station, England, with the view of further development of such masks for mine use, which would be advantageous in both countries. The liaison officer of the bureau was sent to Great Britain to consider with the director of the British board the cooperative research work in hand and plans for the future. He visited official mining organizations in Germany, France, and Belgium, obtaining information regarding instantaneous outbursts of gas, new developments in mine stowage methods, experience with and the requirements for barrier pillars in coal mines; and development of rock-dust methods and practical application in mines of the several countries.

The German experimental coal-dust explosion testing station at Dortmund was loaned scientific apparatus from the bureau's experimental mine near Pittsburgh. Similar apparatus have been installed at the British station. Data on explosion pressures and movements obtained at the three testing stations should better enable compari-

son of the test results of the coal-dust explosion phenomena. The detail of the supervising engineer of the bureau's Experimental mine has been requested to assist in arranging instruments and in carrying on preliminary tests in the new underground galleries at Buxton, England.

Coal-dust explosion hazards in surface plants.—Data were gathered concerning hazards encountered at coal pneumatic-cleaning plants. A safety code for the installation and conduct of such plants was prepared by a member of the bureau's staff and has been adopted and published as a tentative code by the National Fire Protection Association. Many of the proposed requirements would apply to other kinds of surface plants and equipment, in which fine or pulverized coal dust is used.

Oil-sand mining.—Based on investigations of oil-sand mining methods employed near Pechelbronn, France, and Wietze, Germany, a study was made of possible application under certain exceptional conditions in the petroleum fields of the United States. A report was submitted for publication.

Compressive strength of coal and roof supports.—Several years ago, the bureau did extensive testing of various forms of mine-roof supports for a State commission investigating the serious mine subsidence situation in the anthracite fields of Pennsylvania. Its report was not published at the time, but there has been an urgent demand for the test data which were obtained. This information has been incorporated, together with the results of later studies of the strength of coal, in a report published toward the close of the fiscal year.

Experimental mine.—A large part of the investigations conducted during the past year at the Experimental mine, Bruceton, Pa., dealt with the testing of rock-dust barriers, used for the prevention or limitation of coal-mine explosions, with special reference to classifying and approving successful barriers. Many types of barriers have been installed in commercial mines, and facsimilies have failed on test in the Experimental mine. Thus it is seen that such barriers in commercial mines have given a false sense of security. One new type of concentrated barrier was developed and proved successful. Three other types of barriers successfully passed all tests in the Experimental mine. In making this investigation, new facts were found regarding the phenomena of dust explosions. The barrier investigations will soon be finished and a publication summarizing the results is in preparation.

Preliminary large-scale tests of the ignition of coal-dust clouds by electric arcs have been conducted at the Experimental mine. It is planned that the tests of the minimum arc that will ignite the different kinds of coal dust will be started during the coming year.

Mine stoppings.—Tests of the strength of mine stoppings were continued. Some of the underlying physical principles of the resistance of concrete stoppings to explosion pressures were discovered; also it was established that impact pressures against a massive, hence heavy, stopping produced no greater ultimate stresses than gradually applied pressures. The important fact was also developed that a massive stopping tightly placed against the ribs of the mine passage will develop enormously greater strength through arch stresses than

if the stopping was not so tightly buttressed and merely served as a flat plate or beam supported at the ends. Information on this question is needed both for enforcement of certain provisions for explosion-resisting stoppings in the mining regulations on the public domain, and for general use in mines when strong stoppings are needed to resist explosions or hydraulic pressure. It is expected that this work will be concluded in the near future.

WORK OF ECONOMICS BRANCH

It is the function of the economics branch to collect and disseminate statistical data regarding the production, consumption, distribution, and storage of the numerous essential minerals. The results of these statistical and economic studies are widely used by the mineral industries in keeping close touch with market trends and in the solution of business problems.

Accidents to the men employed in the mineral industries of the country result annually in approximately 2,800 deaths and more than 200,000 lost-time injuries. The economics branch conducts statistical canvasses of the number and causes of accidents to persons employed in these industries. Information of this nature is essential to the study of effective means of accident prevention.

COAL DIVISION

The coal division of the economics branch makes studies and furnishes to the Government, the industry, and the public, information on economic conditions and problems of the coal industry of the United States. This work relates to the industrial and commercial economics of coal, as distinguished from scientific and technical problems. The field includes the uses of coal, reserves, prices, production, distribution, consumption, stocks, and marketing and involves the collection, analysis, and dissemination of statistical data relating to the coal and coke industries. Regular features are a weekly coal report covering production, the current trend of consumption, and certain features of distribution; a monthly report covering general conditions in the coal industry; a monthly coke report; a monthly preliminary estimate of coal production; a quarterly report of coal stocks; and the annual chapters on coal, coke and by-products, and fuel briquets for the bureau's publication entitled "Mineral Resources of the United States."

Special effort has again been devoted to improving the accuracy and expediting the publication of the current statistical reports, to increase their value as market information. The weekly estimates of coal production, issued on Saturday of the week following the period covered, are, as checked by final returns from all operators, within 1 per cent of complete accuracy. A special service for business statisticians distributes monthly estimates of production on the 5th of the following month. The division now issues an index to the current reports and distributes mimeographed booklets of the annual statistical returns for both coal and coke, making them available several months ahead of the printed reports. The national associations of coal wholesalers and retailers and bituminous operators telegraph the coal-stock figures to interested members when released, and the weekly production figures are cabled to Europe.

New services inaugurated in 1929 include a weekly analysis of the trend of coal consumption by regions and industries, issued as a guide to distributors and buyers, and current figures on the stocks of by-product coke at producers' works and in retail coal yards. Special investigations published by the division during the year have covered the following subjects: By-product coke as a household fuel; analysis of trends in consumption of coal, 1890 to 1927; sizes of coal shipped; screening equipment at bituminous coal mines; pneumatic cleaning at bituminous coal mines; progress and mechanization of coal mines, 1913 to 1927; and use of loading machines and conveyors.

Government fuel yards.—The Government fuel yards purchase and distribute coal to all Federal and District Government buildings and establishments (except the Washington Navy Yard) in the District of Columbia and to such institutions outside the District as can be economically reached. It maintains its own garage and fleet of 35 heavy-duty trucks; its coal-handling plant has a storage capacity of more than 13,000 tons of coal. During the fiscal year 1929 coal aggregating 238,509 gross tons was delivered to more than 500 points; of the total tonnage 144,884 tons were delivered by trucks from the coal-handling plant and 93,625 tons shipped in railroad cars direct to those plants having their own railroad sidings; the trucks traveled 157,672 miles, with an average round-trip haul of 6.53 miles. The sales value of the coal was \$1,285,036; the sales value of wood, charcoal, and coke, and the charge for service work of hauling materials and of repairing motor vehicles for other branches of the Government was \$28,681, making a total of \$1,313,717. The Government fuel yards operate under a revolving fund, which is maintained by the sales of fuel and reimbursements for services performed.

DIVISION OF MINERAL STATISTICS

Statistics of mineral commodities.—The division of mineral statistics, functioning through its offices in Washington, D. C.; San Francisco, Calif.; Salt Lake City, Utah; Denver, Colo.; and Joplin, Mo., collected statistics of all mineral commodities of commercial importance. Statistics were published promptly in summarized form after completion of the canvass for each commodity, and later in more detail in the annual reports on Mineral Resources of the United States. The division collected information on the mineral resources and mineral production of foreign countries and indexed current information in mining literature on the mineral industries and mineral resources of all foreign countries. It also issued monthly reports of production, shipments, and stocks of Portland cement. The San Francisco office conducted statistical canvasses of gold, silver, copper, lead, and zinc producers in California and Oregon, completed an historical report of metal production in California since 1848, and conducted an inquiry on arsenic, bismuth, etc. The Salt Lake City office, in addition to its regular statistical canvasses of producers of gold, silver, copper, lead, and zinc in Arizona, Idaho, Montana, Nevada, Utah, and Washington, assembled reports on the use of flotation reagents. The Denver office canvassed producers of gold, silver, copper, lead, and zinc in Colorado, New Mexico, South Dakota, Texas, and Wyoming and continued the compilation

of records of production of individual mines in Colorado and New Mexico from 1860 to 1928. The Joplin office collected statistics on metal production in the Central and Eastern States, and prepared general statistical reports on gold and silver and on the production of secondary metals in the United States.

Statistics of accidents, employment, and explosives.—The accident-statistics section canvassed all mines (except coal mines), quarries, coke ovens, and metallurgical plants in the United States, and prepared reports thereon covering accidents, men employed, methods of mining, days of operation, etc. Monthly and annual reports of fatal accidents in coal mines were prepared, based upon information obtained from State mine inspectors. The section also canvassed manufacturers of explosives, and prepared monthly and annual reports on sales of explosives in the United States. A national safety competition was conducted among 284 large mines and quarries situated in 35 States. A bronze trophy was awarded for the best safety record in each of five groups—anthracite mines, bituminous coal mines, metal mines, nonmetallic mineral mines, and quarries and open-pit mines. In cooperation with the health and safety branch, the section prepared statistical compilations based upon medical examinations of miners in the lead and zinc mines of Oklahoma, Kansas, and Missouri, with special reference to the prevalence of silicosis and tuberculosis among the employees.

PETROLEUM ECONOMICS DIVISION

The petroleum economics division makes statistical and economic studies relating to the petroleum, natural gas, and allied industries, and the results of these studies are made available to the industry, the public, and other governmental agencies. The current economic data published are used widely by the industry in planning its operations, as may be judged by the following excerpt from a resolution adopted by the board of directors of the American Petroleum Institute in December, 1928:

The Bureau of Mines has been of incalculable value in collecting and analyzing statistics of the petroleum industry and the prompt dissemination of the bureau's findings has been of great benefit to the industry and the public interest by coordinating production and manufacturing operations to demand, with an important bearing on the conservation of a great national resource.

The work of the division falls under five major headings: Utilization of petroleum products; distribution of petroleum products; statistical reports; assembling of economic data; and foreign studies. The first of a series of studies on the utilization of petroleum products, dealing with petroleum coke, was completed during the fiscal year. Similar surveys covering miscellaneous petroleum products, paraffin wax, asphalts, and other refinery products are planned. Studies of distribution are made to determine the extent to which certain consuming areas depend upon other producing areas for their supply of petroleum products. The annual surveys covering conditions on the Pacific and Atlantic coasts were continued, as was also the National Survey of Fuel-Oil Distribution.

The principal statistical report issued is the Monthly Petroleum Statement, which summarizes the production and consumption of crude petroleum, refined petroleum products, and natural gasoline.

In addition, complete annual statistics of crude petroleum, refined products, natural gas, natural gasoline, carbon black, and asphalt and related bitumens were prepared. In addition to assembling data regarding the location and operating capacities of petroleum refineries and cracking units, the consumption of fuel at refineries, and the average gravities of domestic crude oils, the division published a map showing the natural-gas pipe lines and the position of carbon-black and natural-gasoline plants in the United States.

The division has kept in touch with petroleum production and economic developments in foreign countries, principally through other governmental agencies and periodical publications. A complete review of world oil production was prepared and published as Appendix C of Report III of the Federal Oil Conservation Board, entitled "Petroleum Resources in Foreign Countries and Outlying Possessions of the United States." The Director of the Bureau of Mines is one of the four members of the technical committee advising the Federal Oil Conservation Board. Through the cooperation of the Bureau of Foreign and Domestic Commerce, the Department of State, and various private oil companies and associations, representative samples of crude petroleum from various fields in the Eastern Hemisphere are being assembled. They will be analyzed at the Bartlesville (Okla.) experiment station, and the results of these analyses, together with pertinent economic data, will be published at a joint contribution by this division and the petroleum and natural-gas division of the technologic branch.

RARE METALS AND NONMETALS DIVISION

The rare metals and nonmetals division makes economic studies and disseminates information on a wide variety of mineral industries. During the year, about 1,100 specimens, many of them requiring careful study, were examined and reported upon, and more than 500 visitors were furnished advice and assistance. Approximately 3,300 letters are written each year, mostly in response to requests for specific prices and data not yet incorporated in published reports. In a great many cases the division has succeeded in bringing buyer and seller together to their mutual advantage. New uses are constantly being found for different minerals and more especially for the so-called rare minerals, and valuable deposits remain unworked for long periods simply because their owners do not know where or how to market the products. Last year 260 lists of possible buyers, and 240 lists of producers were furnished in response to requests for market information.

Most of the general industrial surveys conducted by the division are summarized in the various chapters in the bureau's annual volumes of Mineral Resources of the United States, and in information circulars and economic papers. Among the special studies completed, or practically completed during the year, were those relating to graphite, gypsum, ocher, strontium compounds, clay, cadmium, and mineral wool. A report entitled the "Economics of New Sand and Gravel Developments" was sent to the printer. Cost studies of quarry operations in the crushed stone and cement industries were carried forward during the year, and an interim report was issued; similar studies were conducted in the slate industry.

Further studies were made into the economics of slate, granite, asbestos, and other nonmetallic building materials; and comprehensive investigations of the phosphate and barite industries were advanced to the stage of preparing manuscript for publication.

A study of the mica deposits of the United States and the general conditions affecting the domestic mica industry was undertaken in November, 1928, in cooperation with the War Department, and the field work was completed during the fiscal year.

In the corridors of the bureau's building in Washington, the division has prepared a mineral exhibit containing specimens of most of the typical economic minerals and their products, and a variety of rare specimens, including a number of underscribed new minerals. From time to time portions of the exhibit are loaned to other organizations. In order to improve facilities for identifying and determining the commercial possibilities of mineral specimens sent in by prospectors and owners of deposits, the division has equipped a small chemical laboratory and installed a new petrographic laboratory for preparing polished sections and thin sections.

COMMON METALS DIVISION

The common metals division includes in its field the economic aspects of copper, lead, zinc, gold, silver, iron, chrome, manganese, nickel, aluminum, tin, pyrite, and sulphur. In the past year the development of classified-information files on these commodities was continued, and studies were made of the available data which resulted in the publication of Economic Papers 1, 2, 5, and 6, containing summarized data of long-time world production of copper, zinc, lead, and gold. Similar papers of the production series covering silver and tin are in process. The papers of this series present tables showing the production of the subject metals from 1801 to 1927, inclusive, with charts, diagrams, and terse discussion of the sources, amounts, and trends of production.

A paper entitled "Gold Reserves of the United States" was prepared in cooperation with the United States Geological Survey for presentation at the International Geologic Congress at Pretoria, South Africa, in August, 1929. This paper had been requested through the State Department by the Government of the Union of South Africa.

The publication of Information Circular 6084, Consumption of Primary or Virgin Tin in the United States in 1927, resulted from a canvass of consumers of tin conducted by this division. A similar canvass for the year 1928 has been completed and the report written. Papers on world resources of the common metals are being developed.

WORK OF HEALTH AND SAFETY BRANCH

HEALTH DIVISION

The activities of the health division have included experimental studies on carbon monoxide, alkyl halides used for refrigerants, warning agents for manufactured gas, approval of gas masks, analysis of mine gases, acid coal-mine drainage, toxic gases and vapors, causes of death among miners, medical organization and industrial

hygiene, sanitary survey of mining camps, and incidence of silicosis and other diseases among miners.

Carbon monoxide.—The study, described in the last annual report, on the physiological effects of repeated daily exposure of several hours to small amounts of carbon monoxide was continued, but with particular attention to the effect of daily exposure of long duration, such as traffic officers or maintenance men might experience. In the former study, special consideration was given to the safety and comfort of the general public in passing through the Holland Tunnels; this study was made in cooperation with the New York State Bridge and Tunnel Commission and the New Jersey Interstate Bridge and Tunnel Commission.

It was found that, in general, frontal headaches began in some subjects when the saturation reached 18 to 20 per cent, and a few occipital headaches, accompanied by vertigo, occurred at 23 to 28 per cent. Exercise, even though of a mild form, augmented the absorption of carbon monoxide and caused symptoms to appear after shorter exposure. Also, exercise immediately after exposure markedly increased the speed of elimination of carbon monoxide, although this procedure is not recommended or advised as a method of treatment for poisoning by carbon monoxide. The results of this investigation have been published by the Bureau of the Public Health Service as Bulletin 186.

An extensive study of the pathology and blood changes resulting from carbon monoxide poisoning was made from the point of view of ultimately attempting to devise a treatment for the many cases of poisoning that do not respond satisfactorily to the present treatment with oxygen or oxygen-carbon dioxide mixture. Particular attention was given to microscopic pathology of the brain, as the latter appears to be the most important place of injury.

The study of changes accompanying rather rapid poisoning as, for example, the potentially fatal case after 20 to 30 minutes' exposure, was completed, as was also a concomitant series of experiments in which a similar degree of asphyxia was produced by decreasing the amount of oxygen in the air. The latter experiments were undertaken for the purpose of making a direct comparison of the changes resulting from anoxemia produced by the exclusion of oxygen from the blood by carbon monoxide, with anoxemia produced directly by atmospheres deficient in oxygen.

Some work was also done on the changes resulting from a more slowly occurring poisoning, for example, the potentially fatal case after 8 to 16 hours' exposure, and will be continued from the viewpoint of ascertaining the pathology and blood changes occurring during exposure, at the end of exposure, and after a period of two to four weeks following the exposure. On completion of the above investigations, attention will be given to methods of treatment.

In connection with studies pertaining to ventilation of vehicular tunnels and general hazards from automobile exhaust gas, a comparison was made of the amount of carbon monoxide emitted by an engine using ethyl gasoline and ordinary gasoline of the same stock. When the engine was operated under ordinary conditions, no significant difference in the amount of carbon monoxide was found, but when operated under conditions that produced a "knock" with ordinary gasoline, the amount of carbon monoxide per horsepower-hour

was a little less for ethyl gasoline. The results were published as Serial 2908.

Alkyl halides used for refrigerants.—An investigation of the effects on animals of repeated daily exposure to low concentrations of methyl chloride was undertaken. Results of previous work dealing with acute poisoning from a single exposure were published as Public Health Bulletin No. 185 with the title *Physiological Response Attending Exposure to Vapors of Methyl Bromide, Methyl Chloride, Ethyl Bromide, and Ethyl Chloride*, and Public Health Reports, vol. 43, No. 35, with the title *Microscopic Pathology Attending Exposure of Guinea Pigs to Vapors of Ethyl Bromide*.

Warning agents for manufactured gas.—The survey of various ill-smelling substances suggested for injection into the flow of manufactured gas to give warning of the escape of gas through leaks, measurement of intensity of their warning properties, and investigation of their chemical stability and corrosive properties, was completed during the previous year. During 1928–29, field tests were conducted in the city distribution systems of Davenport, Iowa, and Linton, Ind., and a report giving the summarized results of the investigation was prepared and submitted to the American Gas Association. A complete report of the investigation is being prepared for publication.

Approval of gas masks.—The hose mask is the simplest and safest type of respiratory protection available for entering atmospheres containing poisonous gases or in which the oxygen content is low. Testing of gas masks and hose masks was continued for the purpose of establishing a list of equipment for respiratory protection that will meet the requirements of a safe device. The examination and testing of the first hose mask submitted was recently completed. The device passed the requirements and was assigned approval 1409. The following gas masks were tested and approved: All-service gas mask, approval 1405, and the Davis ammonia gas mask, approval 1408. Two publications dealing with the use of gas masks were issued: *Miners' Circular 32, Use of a Type N Miners' Gas Mask*, and *Industrial Gas Masks*, published in the *Transactions of the Institution of Mining Engineers*, vol. 77, part 1, 1929.

Some interesting facts in regard to poisonous gases were brought out in connection with the testing of gas masks. The danger of poisoning by absorption was forcibly brought to the attention of those engaged in testing gas masks for their efficacy in protecting against hydrocyanic acid gas, and it seems advisable to decrease the maximum concentration of hydrogen cyanide gas for which the masks will be approved. In tests of masks for hydrogen sulphide, it was found that the canisters would protect for relatively short periods against 3 or 4 per cent hydrogen sulphide, but that the heat of reaction is so great that it would be impracticable and unsafe to use them in such high concentrations. When using 4 per cent, the canister became red-hot. Tests using methyl chloride have been added to the regular schedule, because the particular type of mask undergoing approval testing may be used for gases encountered in the refrigeration industry.

Analysis of mine gases.—The gas laboratory analyzes the gas samples collected by the bureau's engineers and investigators in

connection with ventilation studies, safety inspections, extinction of mine fires, investigation of coal-mine explosions, approval of mining equipment, etc. During 1928-29 approximately 2,400 samples were analyzed. A miners' circular on Instructions in Methods of Sampling and in the Use of the Bureau of Mines Portable Orsat Apparatus for Analyzing Mine Gases was prepared and a chapter on Illuminating Gas was incorporated in the 1929 edition of the Gas Chemists Handbook published by the American Gas Association.

Acid coal-mine drainage.—Investigations of the character of the drainage from coal mines and coal seams, the factors affecting the formation of acid drainage, the effect on streams and fate of the acid after entering streams, and methods of disposal, were made from the viewpoint of obtaining information to aid in preventing or reducing the amount of undesirable products that enter streams. A report on Observations on Acid Mine Drainage in Western Pennsylvania was published as Serial 2889.

An interesting fact observed in the course of this study was that, while with rare exceptions all active coal mines produce drainage containing acid and the discharge of that drainage into natural streams contributes to pollution from the standpoint of the use of the water for domestic and industrial purposes and as a habitat for aquatic life, the water from a considerable number of mines in the Thick Freeport bed in the vicinity of Pittsburgh is rather strongly alkaline, and, instead of contributing to the pollution of the streams into which the mine-water drains, it actually aids in neutralizing acid that may be present or which may enter later from other sources.

Observations were made during the year of the drainage from sealed mines and sealed sections. In some cases the sealing appeared to have effected a distinct reduction in acid, while in other cases the results are not conclusive and longer periods of observation will be required.

Toxic gases and vapors.—Investigations pertaining to the physiological and pathological action of gases and vapors were made for the purpose of obtaining information necessary for promoting health and safety in the production and utilization of industrial products. A comparative study was begun in connection with the tendency of nitroglycerin and ethylene glycol dinitrate to cause discomforting headaches in the ordinary practice of handling these compounds as explosives. The study included the effect of absorption of the liquid through the skin and vapors through the lungs of persons. The effect on blood pressure and the lethal dosage were determined on animals. The study has not yet been completed.

A number of minor investigations were made of hazards from vapors of benzol, acetone, and gasoline. Assistance was given in investigating the disaster at the Cleveland clinic caused by gases from burning and decomposing X-ray films. A laboratory study of the effect of traces of gasoline, benzol, and alcohol vapors on the efficacy of sodalime granules for removing carbon dioxide was made from the point of view of the use of sodalime in gas masks and self-contained oxygen breathing apparatus.

A study was made of the odor intensity and physiological response attending various concentrations of vapors of propane, butane, pentane, hexane, and heptane in the air. These natural-gas products

are distributed in cylinders under pressure, for use as fuel in rural districts and in industry. The investigation was made for the purpose of ascertaining the relation between explosion hazards and warning properties in event of leaks of gas.

Physiological effects of dust.—The study of the effect of intraperitoneal injection in guinea pigs of suspensions of samples of dust, to determine their suitability for rock-dusting coal mines, was continued. The work will be continued during the coming year along similar lines, with the possible start of a study in which animals will be exposed to dust-laden air for the purpose of ascertaining if the results of injection tests, as manifested in the tendency to form abdominal adhesions, are borne out by the occurrence of fibrous tissue in the lungs.

Physical examination of miners.—The work of the Bureau of Mines Clinic, carried on at Picher, Okla., in cooperation with the Tri-State Zinc and Lead Ore Producers Association and the Metropolitan Life Insurance Co., was continued. Four acting assistant surgeons, together with other personnel, were detailed to the work. During the year 9,208 physical examinations were made and tabulation of the histories up to and including June 30, 1928, has been completed.

SAFETY DIVISION

The miner is confronted with many hazards. He usually works in confined spaces under limited artificial illumination. He is often exposed to dangerous gases. He must handle high explosives, and must be on the lookout for moving trains of coal or ore and for wires heavily charged with electricity. In few other industries is it so necessary for the workers to learn the lesson of safety, the way to prevent accidents, and the art of aiding or rescuing others in distress.

One of the principal functions of the safety division is to instruct miners, quarrymen, oil and gas workers, and employees of metallurgical plants in the principles of first-aid and mine-rescue methods. Since the inception of the Bureau of Mines, more than 365,000 complete courses in first aid and mine rescue have been given, and more than 25,000 persons have been given partial training. During the fiscal years 1927, 1928, and 1929, over 172,000 persons connected with mining and allied industries have received the full Bureau of Mines course of training. Numerous instances of the saving of life as the result of this training are on record. There is good reason for the belief that at least 100 lives are now saved annually directly through the training done by Bureau of Mines instructors; some estimates place the number of lives thus saved as upward of 200 annually.

The safety division operates 10 mine-rescue cars in the United States and 1 in Alaska, whose crews are constantly engaged in giving instruction on first aid and mine rescue in the various mining fields. These cars, as well as the automobile trucks at the bureau's 11 mine-rescue stations, are frequently rushed to the scene of mine disasters, where assistance is given in rescue operations. The division also supervises the work of 11 mine-rescue stations, located in Birmingham, Ala.; Berkeley, Calif.; Seattle, Wash.; Evansville, Ind.; Jellico, Tenn.; McAlester, Okla.; Norton, Va.; Vincennes, Ind.; Salt Lake City, Utah; Wilkes-Barre and Pittsburgh, Pa.; at

each of these stations there is an automobile truck with complement of mine-rescue apparatus.

The safety division also conducts field investigations of mine accidents and explosions, of rescue and recovery methods at mine disasters, and of the use of explosives, electrical equipment, miners' lamps, and breathing and resuscitating apparatus, etc., in mines. The effectiveness of the thorough rock-dusting of bituminous coal mines as a means of preventing disasters has been conclusively demonstrated by bureau investigations, and the engineers of the safety division make field studies of rock-dusting methods and assist in disseminating the results of these studies throughout the mining industries. In this way, they assist in bringing about more effective methods, not only of rock-dusting, but also of other explosion-prevention methods, practices, and installations. They also investigate the causes of individual mine fires or explosions and furnish the operators with reports outlining the best methods of prevention and control or of recovery. During the past year there were transmitted to mine operators 25 formal confidential reports on mine fires and explosions and 47 safety reports; there were submitted by the field men of the safety division more than 100 other reports on accidents and safety conditions, hence the total number of safety reports of various kinds submitted by the field men of the safety division was but slightly under 200 for the year.

Teaching safety to miners.—A total of 81,509 persons were trained in first-aid and mine-rescue practice and given certificates during the fiscal year 1929 by the Bureau of Mines; most of this work was done by the bureau's employees in cooperation with mining companies, other organizations in some cases aiding. Of this number, 1,054 persons received the combination training in first aid and mine rescue, making a total of 82,563 complete courses given. This is the largest number trained in one year by the bureau and is an increase of 32,905 over the number trained in 1928, although the total for that year was 19 per cent above that of any previous like period. An interesting feature again was the sharp increase in initial cooperative training in which the mine operators aided. The number of miners cooperatively trained—that is, trained by key men of the mining companies (these key men being previously trained by the Bureau of Mines) and examined by bureau instructors—was 31,060 as compared to 15,927 during the previous year. It is felt that this method of cooperative training is the most effective for furthering the first-aid and mine-rescue work, and the notable increase in 1929 indicates that the mining industry is gradually assuming its share of the burden of safety training. During the past year, 35 mining companies were given certificates for having 100 per cent of their employees trained in first aid, and several of these companies report that they have noticed a decrease in the number of accidents which have occurred since this training was given.

Advanced safety instruction.—The advanced instruction course given by the Bureau of Mines is designed to educate mining officials in correct mine rescue organization and methods for application at mine disasters. This course is much more technical than the ordinary first-aid and mine-rescue training. Nearly three weeks are re-

quired for this course, and it is difficult for mining companies to release officials for so long a time. During the past fiscal year, 727 certificates in this course were given. To date 2,165 persons have taken this full course, and several hundred others have taken portions of the course in which they were especially interested.

First-aid and mine-rescue meets.—The seventh international first-aid and mine-rescue meet was held under the auspices of the Bureau of Mines in Butte, Mont., August 20, 21, and 22, 1928, a total of 46 first-aid and 12 mine-rescue teams, representing coal and metal mines and petroleum companies, participating. During the year, employees of the safety division assisted in the holding of 94 safety meets in 23 States, a total of 1,541 6-man teams participating in these contests.

Accident-prevention courses.—The first draft of an accident-prevention course for bituminous coal mines was framed during the past year; there were also formulated definite suggestions to govern the safety and welfare of coal miners in coal mines other than anthracite mines. Similar courses in accident prevention for metal mines and petroleum operations are being formulated and will probably be completed in the near future.

Cooperative safety activities.—During the past year, a large amount of safety work has been done in cooperation with State mine-inspection forces in Alabama, California, Colorado, Illinois, Kentucky, Maryland, North Carolina, Utah, West Virginia, and other States. The safety division is also carrying on a study of explosives accidents in Pennsylvania, in cooperation with the State Department of Mines, and cooperative investigations and reports were made on serious mine disasters. Mine-rescue cars 1 and 7 were engaged in an intensive campaign of 100 per cent first-aid training in the State of West Virginia in cooperation with the State inspection department, training having been given in 78 communities in West Virginia during the past year. An engineer of the safety division was assigned to Kentucky, to make safety inspections of the coal mines of Kentucky in cooperation with the various State inspectors, and a similar arrangement was perfected in Utah. An inspection and report were made of treated timbers in a mine in Michigan in cooperation with the University of Wisconsin and the Forest Products Laboratory of the United States Department of Agriculture. In Illinois, Alabama, Maryland, Colorado, and other States, the mine-inspection force of the State assisted materially in forwarding the complete or 100 per cent training of mining companies in methods of first aid to the injured. In North Carolina, California, and other States, the bureau, upon request of State officials, cooperated in giving suggestions as to safety in mines or in industries affiliated with mining.

A notable cooperative activity of the safety division was that in which many of the field men assisted the Portland Cement Association in its no-lost-time-accident drive by giving the bureau's first aid course to several thousand employees in the cement industry.

An extensive cooperative activity is that of guiding the Joseph A. Holmes Safety Association and the Holmes safety chapters. At present, there are 70 active chapters in the Holmes Safety Association, the purpose of which is to promote the safety, health, and welfare of miners and their families.

Miscellaneous activities.—The contract was let for the building of a new steel mine-rescue car to replace car 6, the only remaining rescue car of partial timber construction.

WORK OF ADMINISTRATIVE BRANCH

OFFICE ADMINISTRATION DIVISION

The office administration division is charged with the handling of matters of personnel, accounting, property, and general routine.

Personnel.—On June 30, 1929, there were 881 full-time employees on duty in the bureau, 838 of whom held secretary's appointments. They were distributed and classified as shown in the following table:

Washington	Classification and number of appointees				
	Profes- sional	Subpro- fessional ¹	Clerical	Custo- dial ²	Total
Washington.....	46	8	176	61	291
Pittsburgh.....	90	29	48	60	227
Field in general.....	120	50	54	96	320
Total.....	256	87	278	217	838

¹ Includes instrument makers, first-aid and foreman miners, laboratory aids, assistants, etc.

² Includes motor-truck drivers, janitors, laborers, messengers, etc.

³ Engineers, 20; chemists, 6; miscellaneous, 20; total, 46.

⁴ Engineers, 43; chemists, 38; miscellaneous, 9; total, 90.

⁵ Engineers, 54; chemists, 40; miscellaneous, 26; total, 120.

Besides the employees enumerated in the table, 838, an increase of 100 over the number given in the report for June 30, 1928, there were 43 employees on field agreements, an increase of 12, making the total of 881, an increase of 112 as compared with the preceding fiscal year.

INFORMATION DIVISION

The following table shows by fiscal years the number and character of publications forwarded to the Government Printing Office for printing since 1922:

Bulletins, technical papers, economic papers, circulars, and other publications forwarded to the Government Printing Office for printing, fiscal years 1922-1929

Publications	1922	1923	1924	1925	1926	1927	1928	1929
Bulletins.....	11	17	10	16	16	13	14	22
Technical papers.....	30	28	25	26	26	16	26	21
Economic papers.....								6
Miners' circulars.....	1	1	1	1	1	1	2	4
Annual report.....	1	1	1	1	1	1	1	1
List of publications.....	1	1	1	1	1	1	1	1
Index of publications.....	1	1	1	1	1	1	1	(1)
Handbooks.....	1	1	1					1
Schedules.....	4	3	2		2	3		1
List of motion-picture films.....					1		1	
Mineral resources, separate chapters.....					51	64	57	61
Mineral resources, bound volumes.....						3	3	2
Other publications.....	9	5			2	1	1	
REPRINTS								
Bulletins.....	7		1					
Technical papers.....	11	1	4	1		1	2	1
Miners' circulars.....			14	1	7			
Other publications.....	4	3	2	5	5	4	3	3

¹ Combined with list of publications.

Owing to the lack of printing funds, only part of the printed output of the bureau is issued through the Government Printing Office. In giving to the public the results of the bureau's investigative work, it is necessary to make use of the mimeograph, the technical and trade press, publications of technical societies, and cooperative publications with educational institutions, State and municipal governments, and many other outside agencies. Since the reorganization and transfer of the bureau in 1925, resulting in added duties and increased activities, no adequate provision of printing funds has been made; this lack of printing funds constitutes the greatest single handicap experienced by the bureau.

A total of 120 printed reports and 4 reprints was issued during the year. The mimeographed publications included 68 reports of investigations and 76 information circulars. The purpose of these brief mimeographed publications is to give as promptly as possible to the mining industry and the general public the essential results of investigations that are usually later described in detail in printed reports.

During the fiscal year 384,700 copies of the bureau's printed publications were distributed—29,956 bulletins, 20,807 miners' circulars, 69,478 technical papers, 1,390 annual reports, 3,091 economic papers, 118,357 separate chapters or bound volumes of Mineral Resources of the United States, and 141,621 miscellaneous documents, largely manuals of instruction in first-aid and mine-rescue methods. Proceeds from sales by the Superintendent of Documents of bureau publications do not revert to the Department of Commerce.

Motion-picture production.—As a feature of its work in endeavoring to promote safety and efficiency in the mineral industries, the Bureau of Mines has prepared what is probably the largest collection of educational industrial motion-picture films in the world. These films are intended to explain the different steps in the production, treatment, and utilization of the essential mineral materials, and to illustrate safe methods of mining and preparing minerals. These films are produced through the cooperation of industrial concerns, who bear the entire cost of production.

On June 30, 1929, the bureau had 563 sets of films, aggregating 1,450,000 feet. The number of reels in circulation was 1,473. During the year the films were shown on 9,100 occasions before an estimated attendance of 2,375,000 persons. Distribution of the films is centralized at the Pittsburgh Experiment Station and there are 14 subdistribution centers throughout the country. The films are loaned to schools, churches, clubs, civic and business organizations, scientific societies, miners' local unions, and to others interested. No charge is made for use, but the exhibitor is asked to pay the cost of transportation. The following films were produced during the year: The Power Within (construction, operation, and care of the internal-combustion engine); The Story of a Gasoline Motor; Making It Tough (manufacture of alloy steels); and Carbon Monoxide: The Unseen Danger. The following were thoroughly revised so as to constitute practically new films: The Story of a Spark Plug, The Story of Heat Treatment of Steel, Mexico and its Oil, The Story of Dynamite, The Story of Gasoline, and The Story of Manufactured Abrasives.

CONCLUSION

I have to report that, on the whole, this bureau has just completed the most active and satisfactory year of its existence. While relatively young, the Bureau of Mines is rapidly coming to be recognized as one of the greatest technical bureaus in the Government group.

Very truly yours,

SCOTT TURNER
Director, Bureau of Mines.

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INTER AMERICAN HIGH COMMISSION

INTER AMERICAN HIGH COMMISSION,
Washington, July 1, 1929.

Hon. R. P. LAMONT,
United States Section, Inter American High Commission.

MY DEAR MR. CHAIRMAN: I have the pleasure of transmitting a condensed report upon the work of the commission for the fiscal year 1928-29.

As a result of recommendations approved in February, 1928, by the Sixth International Conference of American States, the United States section of the commission has taken preliminary steps leading to the attainment of definite results from the studies and investigations made by the national sections over a period of years. Of outstanding importance in this connection is the publication in the Spanish language of a detailed report dealing with the laws of the American Republics that govern domestic and foreign stock corporations. The report combines and supersedes five preliminary studies comparing the laws of the Republics with respect to the operations of corporate bodies.

With studies compiled by the United States section used as a basic reference, the sections now are considering proposals for inter-American conventions regarding uniformity in commercial arbitration enforcement and bill of lading legislation. The United States section has under way analyses of other subjects which in due course will be referred to the national sections for consideration in the matter.

Members of the staff assisted in the preparations for the Pan American Trade Mark Conference, held at Washington in February, 1929, compiled documentary material for the conference, cooperated at the sessions, and assisted in the drawing up of the report of the meeting. Likewise, the section is cooperating with the Pan American Union in the development of programs and plans for the forthcoming Pan American Conference on Customs Procedure and Port Formalities and the Inter-American Conference on Agricultural Cooperation.

During the past fiscal year a number of countries have ratified certain of the treaties approved by Pan American Conferences:

The Pan American Sanitary Convention of November 14, 1924, has been ratified by Mexico, Panama, and Uruguay.

The Pan American Postal Convention of 1921 has been ratified by Venezuela. The Convention on the Revision of the Copyright Convention of 1910 has been ratified by Panama.

The Treaty to Avoid or Prevent Conflicts Between the American States has been ratified by the Dominican Republic, Ecuador, and Guatemala.

Very truly yours,

JULIUS KLEIN, *Secretary.*

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U.S. DEPT. COMMERCE.

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