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NINETEENTH ANNUAL REPORT

OF THE

SECRETARY OF COMMERCE

1931

UNITED STATES
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(July 1, 1931)

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CONTENTS

	Page
Introductory statement	VII
Economic review	VIII
Prices	XI
Agriculture	XII
Construction	XIII
Transportation	XV
Banking and finance	XVII
Foreign trade	XX
Elimination of waste	XXIV
Construction and home ownership	XXIV
Domestic marketing service	XXVIII
Simplified practice	XXIX
Certification and labeling	XXX
Commercial standards	XXXII
American marine standards	XXXIII
Scientific research	XXXIV
Utilization and conservation of natural resources	XXXVI
Human safety	XLII
Progress in development of civil aeronautics	XLIX

CONDENSED REPORTS OF BUREAUS

	Page
CHIEF CLERK AND SUPERINTENDENT	
International Colonial and Overseas Exposition	1
Disbursing office	1
Appointment division	3
Division of publications	3
Division of purchases and sales	4
Traffic office	4
Department library	4
Solicitor's office	5
AERONAUTICS BRANCH	
Organization and functions	6
Air regulation service	6
Inspection service	7
Licensing division	8
Medical section	9
Registration section	10
Enforcement section	11
Accident board	12
Engineering section	13
Engine testing section	15
Airways division	16
Air navigation facilities on Federal airways	17
Radio facilities	18
Improvements in airways equipment	22
Aeronautic development service	23
Aeronautic information division	23
Editorial section	23
Statistics and distribution section	25
Airway bulletin section	27
Aeronautics reference library	28
Aeronautic development service—Contd.	
Aeronautics research division	28
Radio section	28
Lighting section	30
Aircraft engine section	31
Wind-tunnel section	31
Engineering section	32
Airport section	33
Airways-mapping section	34
Special research committees	35
Committee on airport traffic control	35
Committee on airport drainage and surfacing	36
Committee on airport zoning and eminent domain	37
Fact-finding committee on control of airplane hangar fires by automatic application of water	37
Liaison committee on aeronautic radio research	38
Administrative division	38
Summary and conclusions	39
RADIO DIVISION	
Legislation	49
Radio inspection service	49
Field survey	51
Radio test cars	51
Mobile standards on radio test cars	52
Monitoring broadcasting stations	52
Constant frequency station	53
Secondary standard monitoring stations	54
Measurement of the quality and quantity of modulation	54

	Page
Radio for aviation	55
Radiobeacons and radiocompasses	55
Automatic alarm signal device	56
Police radio	56
Amateurs	56
International conferences	57
International radio accounting	58

BUREAU OF THE CENSUS

Introduction	59
Volume I of population	59
Final volumes	60
Other activities	61
Bureau personnel	62
New divisions	62
Metropolitan districts	62
Punching and tabulation of returns	62
Punching division	63
Tabulation division	64
Publications division	64
Census of population	64
Preliminary statistics	64
State bulletins	65
General population classification	65
Subject bulletins	65
Occupation statistics	65
Family data	65
Blind and deaf-mutes	66
Census of unemployment	66
Census of agriculture	66
State bulletins	67
County statistics	67
Farm expenses, debts, taxes, etc., and types of farms	67
Special farm tabulations	67
Census of horticulture	68
Irrigation	68
Drainage	68
Census of manufactures	68
Preliminary industry reports	69
Final reports	69
Census of manufactures, 1931	69
Census of mines and quarries	69
Census of distribution	70
Preliminary reports	70
Construction census	70
Hotel census	70
Vital statistics	70
Annual reports	71
Reference books	71
Marriage and divorce	72
Annual census of institutions	72
Financial statistics of State and city governments	73
Current industrial reports	73
Tabulations for outside organizations	74
Old census records	75

BUREAU OF FOREIGN AND DOMESTIC COMMERCE

The domestic business situation	77
Foreign trade	77
The bureau's work in domestic commerce	81
Domestic regional division	83
Merchandising research division	84
Marketing service division	85
Dollars-and-cents results of foreign trade promotion	86
Aid for every region	89
Opportunities for more extensive service	92
The foreign commerce service	95
Intangible benefits to American firms	95
Efforts for increased efficiency	96
District and cooperative office service	97
Distribution of trade opportunities	97
Trade lists furnished	97
Personal contact between district offices and private business	98
Cooperative offices	98
Needed expansion	98
Concrete commodity service for American industries	98
Aeronautics trade division	98
Agricultural implements division	99
Automotive division	100
Concrete commodity service for American industries—Continued.	
Chemical division	101
Electrical equipment division	102
Foodstuffs division	103
Hide and leather division	104
Industrial machinery division	105
Iron and steel division	106
Lumber division	106
Minerals division	107
Motion-picture division	108
Paper division	109
Rubber division	110
Shoe and leather manufactures division	111
Specialties division	112
Textile division	113
Tobacco division	114
Specialized technical services to business	114
Commercial intelligence division	114
Division of commercial laws	115
Division of correspondence and distribution	116
Editorial division	117
Finance and investment division	117
Foreign construction division	118
Division of foreign tariffs	120
Division of regional information	120
Division of statistical research	122
Division of statistics	123
Transportation division	124
Type and regional distribution of commercial services rendered	125

BUREAU OF STANDARDS

General activities	127
Salaries	132
Equipment	137
General expenses	138
Improvement and care of grounds	138
Testing structural materials	138
Testing machines	142
Investigation of fire-resisting properties	143
Investigation of public-utility standards	144
Testing miscellaneous materials	145
Radio research	145
Color standardization	146
Investigation of clay products	147
Standardizing mechanical appliances	149
Investigation of optical and other types of glass	150
Investigation of textiles, etc	150
Sugar standardization	152
Gage standardization	153
Investigation of railroad and mine scales and cars	154
Metallurgical research	155
High-temperature investigation	156
Sound investigation	157
Industrial research	157
Standardization of equipment	163
Standard materials	166
Investigation of radioactive substances and X rays	166
Utilization of waste products from the land	167
Investigation of automotive engines	168
Investigation of dental materials	169
Transferred funds	169
Recommendations	172

BUREAU OF FISHERIES

International relations	175
Revised Northern Pacific Halibut Convention	175
Passamaquoddy power project	178
North American Council on Fishery Investigations	178
International Colonial Exposition at Paris	179
Conservation of whales	179
Japanese vessels in Bering Sea	180
Domestic relations	180
Aid to our island dependencies	180
Fisheries conferences	181
Cooperation with States	182
Five-year construction and maintenance program	183

Page

Propagation and distribution of food and game fishes 183
Introduction 183
Propagation of commercial species 185
Propagation of game fishes 186
Rescue operations 186
Cooperative activities 186
Statistical surveys 187
Fisheries of the United States and Alaska 187
Manufactured products 188
Fish-farming industries in the United States 189
Foreign fishery trade 189
Technological investigations 189
Improvements in methods of handling fresh fish 190
By-products and production methods 190
Net preservation 191
Nutritive value of marine products 191
Gloucester laboratory 192
Biological fishery investigations 193
Fishery investigations of the Atlantic and Gulf coasts 193
Fisheries of interior lakes 194
Fisheries of the Pacific coast and Alaska 195
Fish screen and fish ladder investigations 196
Aquicultural investigations 196
Shellfish investigations 197
Alaska fisheries service 199
Administration of fishery laws and regulations 199
Alaska salmon hatcheries 199
Special studies and investigations 200
Products of the fisheries 200
Alaska fur-seal service 200
General activities 200
Seal herd 201
Take of sealskins 201
Marking reserved seals 202
Sale of sealskins 202
Foxes 202
Fur-seal skins taken by natives 202
Fur-seal patrol 203
Protection of sea otters, walruses, and sea lions 203
Black bass law enforcement 203
Vessel notes 204
Appropriations 205

LIGHTHOUSE SERVICE

Activities during year 206
Aids to navigation 207
Engineering construction 208
Improvements in apparatus and equipment 208
Administration 211
Personnel 212
Lighthouse depots 212
Vessels of the Lighthouse Service 212
Lighthouse tenders 213
Lightships 213

COAST AND GEODETIC SURVEY

Hydrographic and topographic work 215
Geodetic work 217
Tide and current work 220
Magnetic and seismological work 223
Chief clerk 224
Division of accounts 224
Division of instruments 225
Division of hydrography and topography 226
Division of geodesy 227
Division of charts 228
Division of tides and currents 230
Division of terrestrial magnetism and seismology 231

BUREAU OF NAVIGATION

American shipping on June 30, 1931 233
Navigation laws 234
Load lines 234
Coasting trade 235
Inspection of motor ships 235
International convention on safety of life at sea 236
International convention on load lines 236
Load line act of March 2, 1929 236
Admeasurement of vessels 237
Administration of the navigation laws 237
Navigation patrol service 238
Enforcement of navigation laws 238
Preventing overcrowding of passenger vessels 241
Shipping commissioners 242
Passenger act of 1882 243
Navigation receipts 244
Publications 244

STEAMBOAT INSPECTION SERVICE

Personnel 245
Improved ship construction 245
Hulls and equipment 245
Boilers and machinery 246
Ships' personnel 247
Examinations for licenses 247
Officers and crew 247
Action against licenses 247
Lessons learned from disasters 247
Expenditures 248
Hulls and equipment statistics 249
Vessels inspected and certificates of inspection issued 249
Miscellaneous inspections 251
Reinspections 251
Certificates withdrawn or refused 252
Cargo vessels examined to carry persons in addition to crew 252
New life preservers inspected 252
Life-saving apparatus inspected at factories 252
Work performed by inspectors in central office 252
Boilers 252
Marine-boiler plates tested 253
Steel bars and forgings tested 253
Statistics concerning ships' personnel 254
Officers licensed 254
Results of action against licenses 256
Examinations for color blindness 256
Certificates of service issued to able seamen and to lifeboat men 256
Transportation and loss of life 257
Passengers carried 257
Lives saved 257
Lives lost on vessels subject to inspection 258
Accidents resulting in loss of life 259
Vessels lost 260
Property lost 260

PATENT OFFICE

Aiding industry 263
Statistics 264
Other details of business for the fiscal year 267

BUREAU OF MINES

Finances 269
Technologic branch 272
Mechanical division 272
Mining division 277
Metallurgical division 282
Petroleum and natural-gas division 289
Experiment-stations division 294
Helium division 302
Office of the chief mining engineer 304
Economics branch 306
Coal division 306
Mineral-statistics division 308
Petroleum-economics division 309
Rare metals and nonmetals division 311
Common-metals division 313
Principal mineralogist 315
Health and safety branch 315
Health division 315
Demographical division 323
Administrative branch 326
Office-administration division 326
Information division 327
General considerations 329

FEDERAL EMPLOYMENT STABILIZATION BOARD 330
INTER-AMERICAN HIGH COMMISSION 335

NINETEENTH ANNUAL REPORT

OF THE

SECRETARY OF COMMERCE

DEPARTMENT OF COMMERCE,
OFFICE OF THE SECRETARY,
Washington, November 4, 1931.

To the PRESIDENT:

I have the honor to submit herewith the Nineteenth Annual Report of the Secretary of Commerce in the following parts:

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

The Director of the Bureau of Foreign and Domestic Commerce in his report has discussed in detail our foreign trade for the past year and for that reason a separate review of that subject has not been submitted.

As the Fifteenth Decennial Census was taken as of April 1, 1930, the Director of the Bureau of the Census has embodied in his report detailed information concerning that enumeration and the tabulation of the results as well as the several other censuses taken at the same time. Therefore special attention is invited to the report of that bureau.

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

Very sincerely,

R. P. LAMONT,
Secretary of Commerce.

ECONOMIC REVIEW

During the fiscal year ended June 30, 1931, the United States suffered from a severe depression world-wide in extent. The accumulation of large stocks of raw materials and foodstuffs throughout the world, extensive declines in the prices of commodities, securities, and real estate, the unsettlement of political and fiscal conditions in many foreign countries, widespread unemployment in the leading industrial nations, have all contributed to the difficulties of the United States, which have been further accentuated by the effects of a severe drought throughout a large portion of our agricultural area.

Following upon some evidence of business stability and improvement in the spring of 1930, industrial production and employment, the volume of domestic and foreign trade, and the prices of securities and commodities declined sharply during the remainder of that year. During the first half of 1931, however, the volume of production and distribution and factory employment gave indications of stability, and some improvement of more than seasonal proportions occurred, particularly in the consumers' goods industries and in retail trade. Unemployment, which had risen to high levels during the winter, was reduced somewhat by seasonal expansion in several lines of business.

Commodity prices continued their decline, however, and recessions were particularly severe in the case of the great agricultural staples which were faced with unwieldy surpluses and the prospect of very large yields in the current crop year. By the last month of the fiscal year business activity had subsided to about the levels of midwinter, while stock and commodity markets had reached new low levels. The President's proposal, on June 20, for a 1-year moratorium on reparations and intergovernmental debts had a salutary effect on business sentiment in this country and abroad which was promptly reflected in an upturn in commodity and security values.

Major economic indexes

[Based on calendar years 1923–1925=100]

Year ended June 30 and month	Manufacturing production	Minerals production	Railroads, ton-miles revenue freight	Electric power production	Department store sales (value)	Department store stocks	Manufactured goods stocks	Factory employment	Factory pay rolls
1920	91	82	96	----------	88	95	86	112	113
1921	73	83	90	70	92	97	90	92	98
1922	75	69	79	72	84	89	91	84	74
1923	98	93	96	88	94	92	87	99	95
1924	97	102	97	95	99	101	101	101	102
1925	99	98	98	102	100	101	104	96	96
1926	106	99	105	116	104	103	104	101	103
1927	109	113	111	129	107	103	110	100	104
1928	106	103	104	138	107	102	117	97	100
1929	118	112	110	154	110	100	120	100	106
1930	110	110	104	163	108	99	121	97	101
1931	87	91	[1] 86	155	98	88	120	80	76
June, 1929	[2] 129	[2] 112	109	155	[2] 113	[2] 98	122	[2] 103	110
June, 1930	[2] 100	[2] 100	92	155	[2] 103	[2] 96	126	[2] 90	91
June, 1931	[2] 84	[2] 85	76	150	[2] 95	[2] 82	118	[2] 76	68

[1] Preliminary.

[2] Adjusted for seasonal variation.

The best measure of industrial activity in the United States is furnished by the Federal Reserve Board's index of production which, for the past fiscal year, averaged 20 per cent less than in the preceding year and 25 per cent below the unprecedented volume of the fiscal year 1928–29. Despite the severity of the depression, it is important to note that industrial production in the last fiscal year was in greater volume than in the calendar years 1920 and 1922, and 31 per cent more than in the depression year 1921.

Manufacturing plants continued to curtail operations during the last six months of 1930, and in December their activity was at the lowest point of the current depression. Conditions improved continuously during the next four months. In April, 1931, the index of factory production was about 20 per cent higher than the December low point and, if allowance is made for the usual seasonal improvement, the increase amounted to 11 per cent. There was a slight decline in May and again in June, the seasonally adjusted index in the latter month standing at 16 per cent below the same month of the previous year but 5 per cent above December, 1930.

Although the decline in production has been general, there has been a wide disparity in the severity of recession in various fields. The heavy industries experienced the greatest declines; iron and steel output in the past fiscal year was 37 per cent below the volume for the year preceding, automobile output fell off 36 per cent, while production of nonferrous metals declined 25 per cent. Consumers' goods industries, on the other hand, held up to relatively higher levels, with a decline of only 4 per cent being recorded by food products and of only 3 per cent by tobacco products, while the textile, leather, and rubber tire groups showed declines ranging from 11 to 15 per cent.

The seasonally adjusted index of mineral production, while moving much more erratically than that of manufacturing production, tended downward throughout 1930–31, and for the fiscal year just closed averaged 17 per cent less than in the fiscal year 1929–30. Actual production of minerals which reached the lowest point in March, 1931, showed seasonal improvement during the following three months. If allowance is made for normal seasonal change, the June index, which was 15 per cent below a year ago, marks the lowest point thus far recorded in the present decline.

Of the eight individual minerals combined in the index of mineral production the output of bituminous coal, anthracite, and crude petroleum compared most favorably with the preceding fiscal year with declines ranging from 6 to 17 per cent. The curtailment of operations in the heavy manufacturing industries was reflected in decreased demand for iron ore, shipments of which were 38 per cent less than in the previous year. The other minerals—copper, lead, zinc, and silver—showed production ranging from 22 to 32 per cent under the preceding fiscal year.

Curtailment of industrial operations resulted in the release of additional factory workers and further reduction in pay rolls. For the fiscal year as a whole the Federal Reserve Board's index of factory employment averaged 18 per cent below the level of the preceding year, while pay rolls were 25 per cent smaller, reflecting an increase of part-time operations. It is significant that the decline in

factory employment from the high levels of 1928–29 has been considerably less, and the curtailment of pay rolls slightly more, than the decrease in production of manufactured goods as measured by the Federal Reserve Board's index. Although the contraction of employment and pay rolls was sharpest in the case of manufacturing and mining industries, the lessened demand for the goods and services of the transportation and other public-utility industries, the construction industry, mercantile business, and the various service industries resulted in the release of many workers in these fields.

Unemployment increased steadily during the fall and winter and reached a seasonal peak in January, 1930, when it was estimated on the basis of special census taken in that month, that the number of jobless workers was slightly in excess of 6,000,000. After that time the volume of unemployment was somewhat reduced as a result of seasonal demand for workers in agriculture, construction, and certain other industries. With the seasonal curtailment of these activities as winter approaches, the volume of unemployment must be expected again to increase unless there is substantial improvement in business.

When the depression commenced in 1929, world stocks of raw materials and foodstuffs had already reached record high levels and during the following two years, despite curtailed operations in many lines, huge additions were made to these surpluses. During the past fiscal year the Department of Commerce index of domestic raw material stocks averaged 7.4 per cent larger than in the preceding year while the index for June, 1931, was 17.0 per cent above that for the same month of 1930. The situation with respect to stocks of manufactured goods is much more satisfactory. After rising above predepression levels during the fiscal year 1929–30, the index has since turned downward and at the end of the past fiscal year was about 6 per cent below the preceding year and at the same level as in June, 1928.

By reason of the fact that mining, manufacturing, and construction were in a smaller volume the facilities of our transportation companies and our distributing agencies were used to a less extent than in other recent years. Ton-miles of revenue freight carried by railroads was 18 per cent less than in the previous year, while total freight-car loadings fell off by 17.4 per cent. It is notable that loadings of merchandise in less than car lots, which measure the movement of finished goods for consumption, was only 10.5 per cent less than in 1929–30.

In spite of the large amount of unemployment and the decrease in national income there was a strong demand for many classes of consumers' goods. Although the dollar value of department-store sales declined 9 per cent between the last two fiscal years, the decline was probably offset, possibly more than offset, by declines in the retail price of commodities ordinarily sold in department stores. Sales of two mail-order houses declined 14 per cent between the two periods, but if allowance is made for the lower price levels of 1930–31 the decline in the volume of sales was relatively small.

Department-store stocks, which have been reduced substantially since the beginning of the depression, were less in June, 1931, than at any time since 1919. In part this reduction of stocks has reflected the effects of better systems of inventory control and more rapid

turnover during recent years, but the reduction of retail stocks during the past 18 months has been at an accelerated rate with ample evidence that in many instances existing inventories are insufficient even for the current volume of sales. With the return of confidence and expansion of purchasing power retail stocks can be expected to increase substantially.

PRICES

The extensive downward movement of prices which started about the middle of 1929 had not reached bottom in June, 1931, although wholesale prices in that month averaged only fractionally higher than in 1913. This sharp trend toward lower levels, which has caused so much uncertainty and hesitancy in the business world, has not been confined to the United States. Price declines in this country have been smaller than in many of our foreign markets and some of the greatest drops have occurred in those commodities most important in international trade.

The combined index of wholesale prices constructed by the Bureau of Labor Statistics averaged 16.5 per cent lower in the fiscal year 1930–31 than in the preceding fiscal year. Farm products prices averaged almost one-fourth lower as a result of the general decline in the prices of all types of farm products. Food prices declined about 17 per cent, while commodities other than farm products and foods, consisting mostly of fabricated articles and minerals, declined 13 per cent.

Rubber prices averaged 51 per cent lower in the last fiscal year than in the fiscal year preceding; hides and skins, silk and rayon and nonferrous metals averaged nearly one-third lower, and petroleum products averaged somewhat more than one-fourth lower. Declines ranging from 15 to 22 per cent occurred in prices of leather, cotton goods, lumber, paint materials, and miscellaneous textiles; and prices of boots and shoes, iron and steel, brick, drugs and pharmaceuticals, fertilizer materials, fertilizers, and paper and pulp were lower by from 5 to 10 per cent. Prices of anthracite coal, coke, agricultural implements, and cement averaged only slightly lower in 1930–31 than in 1929–30.

Price indexes

[Calendar years 1923–1925=100]

Item	Fiscal year ended June 30—									June, 1930	June, 1931
	1923	1924	1925	1926	1927	1928	1929	1930	1931		
Wholesale prices:											
General average	100.5	97.4	99.8	101.8	96.1	95.8	96.7	92.8	77.4	86.2	69.5
Farm products	94.1	95.3	103.7	103.3	93.7	101.9	102.2	97.2	73.6	86.5	63.6
Foods	96.8	95.8	101.3	107.3	103.0	104.3	106.0	103.2	85.8	95.7	76.5
Other products	104.7	99.1	98.2	99.8	94.7	91.0	91.2	88.4	76.7	83.9	70.4
Hides and leather products	103.8	97.2	101.0	98.3	97.5	114.6	109.9	102.5	88.8	98.7	84.7
Textile products	99.2	99.7	98.6	96.5	88.1	88.9	88.0	82.0	66.1	75.6	60.1
Fuel and lighting	115.8	96.8	97.1	102.7	99.8	86.5	87.0	83.7	72.5	80.2	61.0
Metals and metal products	100.1	101.5	98.3	94.4	93.6	92.2	96.9	95.2	84.7	89.7	82.2
Building materials	102.6	100.9	97.3	96.7	93.6	88.3	92.4	91.6	80.1	86.4	74.4
Chemicals and drugs	100.5	98.6	99.7	100.8	97.6	95.4	94.6	91.9	83.0	88.4	77.4
House furnishing goods	101.2	101.5	98.6	96.2	93.4	93.1	91.6	91.7	87.7	91.1	83.9
Miscellaneous	96.7	94.6	95.6	111.6	91.4	86.7	79.4	78.7	66.0	73.9	61.3
Farm prices	93.0	95.0	102.0	103.0	93.0	99.0	98.0	96.0	70.0	88.0	57.6
Retail foods	95.4	97.8	100.1	108.0	105.0	102.6	103.3	103.8	89.3	98.7	79.0
Cost of living	96.1	99.2	100.3	102.5	100.7	98.7	98.0	97.6	89.9	94.8	84.4

By reason of very sharp declines in all agricultural products, the combined index of farm prices (prices received by the farmer) compiled by the Department of Agriculture dropped over one-fourth for the fiscal year 1930–31 as a whole as compared with 1929–30. A drop of 39 per cent occurred in prices of cotton and cottonseed, and there were declines of from 25 to 31 per cent in prices of livestock, fruits and vegetables, grains, and poultry products. Prices of dairy products averaged 18 per cent lower. The only group of farm products the farm prices of which on July 15, 1931, were higher than before the war was that of fruits and vegetables; other groups ranged from 8 per cent to 43 per cent below pre-war levels.

Retail prices do not usually fluctuate as widely or as rapidly as do prices of commodities at wholesale, partly for the reason that they include many items of cost which change slowly; nevertheless, during the past fiscal year retail prices of foods averaged nearly 14 per cent lower than in the fiscal year preceding, a decline only slightly less than that shown in wholesale prices of foods; the decline from June, 1930, to June, 1931, was the same for each, 20 per cent. Meat prices averaged nearly 14 per cent lower during the fiscal year 1930–31 than during 1929–30, dairy products averaged 11 per cent lower, and prices of cereal foods were about 8 per cent lower.

The cost of living index compiled by the National Industrial Conference Board averaged 8 per cent lower from July, 1930, to June, 1931, than during the same period of 1929–30. Aside from retail prices of foods already discussed, the greatest decline occurred in prices of clothing, 11½ per cent. Rents were reduced 5½ per cent, but fuel and light and sundry items declined less than 2 per cent. In June, 1931, the cost of living was 11 per cent lower than in June, 1930, and 16 per cent below the high point reached in 1929.

AGRICULTURE

Agricultural production as a whole declined in 1930, crop production being 5 per cent less than in 1929, largely due to the severe reduction of the corn and hay crops by drought. At the same time markets for several of the "cash crops" were somewhat curtailed by the industrial depression, and a precipitate world-wide decline in prices affecting all products took place. Principally as a result of the fall in prices, the aggregate farm value of crops declined from $9,562,000,000 in 1929 to $6,964,000,000 in 1930.

Agricultural cash income, which represents to a great extent the farmer's purchasing power, declined 23 per cent from 1929 to 1930. Details of farm values and gross and cash income for several years past are presented in the following table:

Estimated farm value of products, gross income, and cash income, calendar years 1924–1930

[Value in millions of dollars]

Item	1924	1925	1926	1927	1928	1929	1930
Crops:							
Farm value	10,537	10,008	9,285	10,078	9,806	9,562	6,964
Gross income	6,240	6,225	5,540	5,902	5,737	5,688	4,032
Cash income	5,570	5,505	4,870	5,270	5,091	5,012	3,453
Animal products:							
Farm value	5,086	5,820	6,078	5,978	6,205	6,490	5,514
Gross income	5,166	5,819	6,010	5,797	6,061	6,295	5,370
Cash income	4,137	4,655	4,856	4,683	4,965	5,194	4,423
Grand total (excluding duplications):							
Gross income	11,406	12,043	11,550	11,699	11,798	11,983	9,402
Cash income	9,707	10,160	9,726	9,954	10,056	10,205	7,876

During the first half of 1931 conditions in the 1930 drought area improved greatly, but two other areas—the Pacific Coast and Northern Plains States—were experiencing unusual drought and heat.

A corn crop larger than the 5-year average is indicated by conditions during the first half of 1931. A wheat crop greater than in 1930 was being harvested at a time when world supplies were the largest and prices the lowest in many years. The production of meat animals has continued undiminished. The cotton crop also is large, and here again world supplies are exceptionally high and prices correspondingly low.

The aggregate production of all agricultural commodities has not varied greatly in the last few years, and variations in farm income have been due mostly to variations in price. Prices of our two major "cash crops," wheat and cotton, are determined by world conditions, and world visible supplies of both of these commodities have been steadily mounting in recent years. During the past fiscal year prices received by producers of wheat and cotton declined 40 per cent and 45 per cent, respectively, and, although better conditions relative to other products have served to mitigate the situation viewed as a whole, it was inevitable that some real distress in the industry should result and that the reduced farm buying power should make its influence felt throughout the business community.

CONSTRUCTION

Building and engineering construction, as a whole, was characterized in 1930–31 by a drop to levels lower than for several years past and by a sharp reduction in construction costs. The total value of reported contracts for all types of construction in 36 Eastern States for the fiscal year 1930–31 was 32 per cent less than in 1929–30, while floor space of building construction decreased 34 per cent. The individual classes of construction showed marked differences in behavior.

The actual physical volume of public-works construction was approximately equal to that during the preceding fiscal year. Although there was a 9 per cent decrease in the value of contracts awarded for 11 subclasses of public construction, this was substantially offset by the lower level of construction costs. The Federal Government

showed an increase of about 30 per cent in its expenditures for construction as compared with the preceding fiscal year, thus contributing materially to the general program to sustain employment.

The State governments were able to maintain their programs at a high rate, while the municipalities and other local governments, in spite of special efforts to expedite public works as a means of lessening unemployment, were unable to prevent a decrease, in the face of lowered assessments and impaired revenues.

Residential building, which had begun to fall off in volume even before the depression set in, declined only 20 per cent in floor space during 1930–31 from the preceding year. Although residential vacancies appear to have increased slightly during the year, they were not excessive at any time; the rate of new construction was substantially below that of any reasonably computed trend line, and is thus contributing to the future demand that will develop whenever general business activity picks up, and families cease doubling up and seek better quarters once more.

The decline in building of hospitals and institutions, and religious and memorial structures, all public or semipublic items, was about the same as the decline in value of all construction.

Public-utility companies, including the railways, went forward with construction programs instituted during the early part of the depression, but had to curtail substantially the undertaking of further new projects, although not to such a marked degree as was the case with factories and other types of industrial building. There was a sharp falling off in commercial building.

Shipments of Portland cement, which is used in virtually all types of construction, fell off only 13 per cent from the preceding year, the large volume of road building having counted in favor of this material. However, the volume was less than in any year since 1924.

The distinct downward trend in building-material prices, which commenced in 1929, after several years of comparative stability, was continued. The Bureau of Labor Statistics' wholesale price index of building materials, as stated on a 1913 base, dropped from 173 in October, 1929, to 137 in June, 1931, which is the lowest index number since early in 1917.

Among other items, improvements in construction methods and machinery have resulted in greater output per man-hour, especially during the past two years, and thus have contributed toward lowering the cost of all types of building and construction.

Construction contracts awarded in 36 States, fiscal years 1928–1931

[Source: F. W. Dodge Corporation]

Class	Value (millions of dollars)				Floor space (millions of square feet)			
	1928	1929	1930	1931	1928	1929	1930	1931
Total	6,329	5,990	5,148	3,520	[1] 877	[1] 847	[1] 608	[1] 404
Residential	2,712	2,281	1,365	980	536	468	268	214
Public works and public utilities	1,256	1,250	1,387	1,119				
Industrial and commercial	1,394	1,571	1,492	687	212	257	215	92
All other	967	888	903	734	130	122	124	98

[1] Floor space of public works and public utilities not included.

Construction statistics, fiscal years 1922–1931

[Based on calendar years 1923–1925=100]

Item	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931
Indexes of volume of business:										
Construction contracts awarded—										
Value, including public works and public utilities [1]	(2)	(2)	88	101	129	130	133	126	109	74
Floor space of buildings [1]	(2)	(2)	92	95	122	107	116	112	81	53
Residential construction—										
Value [1]	(2)	(2)	75	82	109	98	105	88	53	38
Floor space [1]	(2)	(2)	79	78	104	87	99	86	50	40
Public works and public utilities, value [1]	(2)	(2)	73	89	103	128	138	137	152	123
All other construction—										
Value [1]	(2)	(2)	72	85	110	113	106	111	108	64
Floor space [1]	(2)	(2)	75	80	98	94	94	104	93	52
Cement shipments	71	90	93	105	108	113	116	118	116	101
Price indexes:										
Frame-house materials, retail	(2)	99	103	98	97	95	90	88	88	82
Building-material prices, wholesale	89	103	101	97	97	94	88	92	92	80

[1] 36 States. [2] Comparable data not available.

TRANSPORTATION

The existing economic conditions throughout industry generally in the United States during the past fiscal year were reflected in the substantially lower total operating revenue and net operating income received by Class I railways, the activities of which constitute approximately 98 per cent of the total railway business of the country.

The total operating revenue of those roads during the fiscal year ended June 30, 1931, was $4,838,139,000, a decline of 19.1 per cent from the amount received for the fiscal year 1930 and 23.6 per cent less than in 1929. The net operating income for the current fiscal year amounted to $746,182,000, as compared with $1,088,295,000 in 1930 and $1,294,470,000 in 1929. This 1931 total represents a decrease of 31.4 per cent when compared with the 1930 figures and a decline of 42.4 per cent from the 1929 total.

The volume of revenue freight traffic handled by Class I railways during the fiscal year 1931 was 349,916,000,000 ton-miles, a decline of 17.3 per cent from 1930 and 21.7 per cent from 1929. During the same period passenger miles declined 29.2 per cent from 1930 and 28.7 per cent from 1929.

These heavy shrinkages in the volume of railway traffic and income furnished the basis for an appeal in June, 1931, from the carriers to the Interstate Commerce Commission for a flat increase of 15 per cent in freight rates. In presenting that appeal the management of the carriers stated that, if granted, the higher rate schedule would enable the roads to earn at least an additional $500,000,000 per annum. In this action the railroads received the support of banking and other interests whose holdings of railroad securities are heavy but met strenuous opposition from shippers generally and the agricultural interests in particular. The commission's decision of October 16, 1931, denied the application for a 15 per cent increase and made other suggestions regarding increased revenues.

Notwithstanding this loss in income, the roads through constant improvement in equipment and refinement in methods of operation have continued their efforts to improve an already highly efficient

transportation machine. New records were made in increasing freight-train speeds and in the consumption of fuel per traffic unit handled. Improved passenger service has been made available and many lower passenger rates have been established to increase passenger traffic and to further competition with other modes of transportation. One large eastern system is proceeding with the work of electrifying its lines, at an estimated total cost of $175,000,000.

The average number of men employed during the year showed a decrease of 15.2 per cent from the 1930 total. Efforts on the part of the roads toward preventing a greater volume of unemployment were made in some cases by working full shop forces part time and by undertaking a greater amount of maintenance work than current activities demanded. Under special accounting regulations obtained from the Interstate Commerce Commission the carriers provided extra work for 6,000 men for a number of months in dismantling 30,500 units of obsolete equipment. Since November 1, 1929, no less than 67 certificates of "convenience and necessity" were obtained by the carriers from the Interstate Commerce Commission for the construction of 1,678 miles of new line, at a cost of $244,193,172.

Operating statistics of Class I railways, fiscal years 1922–1931

[Source: Interstate Commerce Commission and American Railway Association]

Item	1922	1925	1926	1927
Freight ton-mileage (millions):				
Revenue	313,439	396,621	427,385	449,285
Nonrevenue	38,097	40,766	43,398	46,192
Tons of revenue freight originated (thousands)	940,056	1,210,118	1,273,048	1,351,076
Cars loaded (thousands)	40,658	49,678	51,905	53,627
Net tons per train, average	656	731	752	786
Net tons per loaded car, average	26.8	27.0	27.0	27.6
Average daily car surplus	272,756	252,410	218,779	213,154
Average daily car shortage	2,410	295	435	287
Bad-order cars, average number	339,369	194,519	172,252	144,668
Bad-order locomotives, average number [1]	15,764	11,514	10,478	9,302
Employees, average number	1,643,000	1,765,000	1,782,733	1,798,495
Total operating revenues (thousands of dollars)	5,508,169	6,011,864	6,325,158	6,442,387
Net operating income (thousands of dollars)	818,345	1,033,766	1,194,832	1,209,535

Item	1928	1929	1930	1931
Freight ton-mileage (millions):				
Revenue	420,312	447,024	423,067	349,916
Nonrevenue	44,330	44,763	42,643	34,279
Tons of revenue freight originated (thousands)	1,246,228	1,320,086	1,280,828	1,032,873
Cars loaded (thousands)	50,576	52,716	50,418	41,660
Net tons per train, average	776	803	799	767
Net tons per loaded car, average	26.7	26.8	26.9	26.3
Average daily car surplus	303,408	232,378	326,719	552,421
Average daily car shortage	133	57	44	None.
Bad-order cars, average number	141,508	142,672	141,796	155,304
Bad-order locomotives, average number [1]	8,880	8,343	8,103	6,595
Employees, average number	1,711,200	1,679,553	1,639,881	1,391,118
Total operating revenues (thousands of dollars)	6,096,483	6,334,043	5,983,954	4,838,139
Net operating income (thousands of dollars)	1,074,341	1,294,470	1,088,295	746,182

[1] Includes switching and terminal engines.

Ocean shipping in this country as well as abroad inevitably has felt the effects of the present recession in oversea trade. Idle tonnage in the United States on June 30, 1931, represented an increase of 32 per cent over last year. In comparison, total idle tonnage in the principal foreign countries denoted an increase of about 125 per cent

over a similar period. The percentage increase in idle tonnage in this country was limited through the withdrawal of laid-up shipping for scrapping purposes and the maintenance of established trade routes.

In shipbuilding, the present situation is relatively favorable to the United States as compared with the combined total of the principal foreign shipbuilding countries. At the end of the fiscal year 1931, a decline of 25 per cent in tonnage under construction was noted in American yards in comparison with a 45 per cent decrease in foreign yards. This situation is attributable very largely to the stimulus of the merchant marine act of 1928, which liberalized the Government's construction loan facilities and provided higher rates for the carriage of ocean mails, with the view to retiring the Government from shipping and developing a modern privately owned merchant marine.

The participation of American shipping in the carriage of our waterborne foreign trade, on the value basis, is shown by the following figures: Exports—1931, 35.2 per cent of the total; 1930, 35.4 per cent. Imports—1931, 34.4 per cent of the total; 1930, 32.1 per cent.

Progress in the development of inland waterway facilities continued during the year. The appropriations for river and harbor improvement authorized by the last Congress make available $80,000,000, which will be utilized in beginning work on new projects and carrying forward projects already commenced. The completion and opening of new modern terminals at Cincinnati, Ohio; Evansville, Ind.; and Peoria, Ill., were accomplished during the year.

An economic and potential traffic survey of conditions existing in the Altamaha River area of Georgia has been completed and similar work on the Calumet River project in Illinois is under way. The latter project proposes to furnish the last link needed for a through channel of 9 feet minimum depth from the Lakes to the Gulf of Mexico.

BANKING AND FINANCE

Conditions in the financial markets during the fiscal year 1930–31 were in general indicative of further recessions in business and security market activity. A combination of factors, such as have characterized the depression phase of the business cycle in the past, together with the effects of drought and other unusual influences, resulted in a number of bank suspensions which in turn tended to delay business recovery. Business activity, as measured by such indexes as bank debits and commercial loans, moved to levels lower than those of the fiscal year, 1929–30, and the short-term credit situation was considerably eased and money rates stood at record low levels as the fiscal year closed.

After a period of steady liquidation in the security markets during the closing months of the calendar year 1930, renewed buying activity set in during the first quarter of 1931. The total market value of stocks listed on the New York Stock Exchange stood at approximately $64,000,000,000 at the beginning of July, 1930, and, after declining to less than $50,000,000,000 by the beginning of 1931, rose to $57,000,000,000 by the beginning of March. During the remainder of the fiscal year both quotations and total market value moved gradually downward. The change for the fiscal year was a drop of approximately 38 per cent in the general level of stock prices and a shrinkage of $16,475,-

000,000 in the market value of the stocks listed on the Stock Exchange. The combined index of 12 industrial and trade groups, including 337 stocks, declined 40 per cent during the fiscal year, while the averages of 33 rail stocks dropped 41 per cent and 34 public-utility stocks showed a net price loss of 31 per cent.

Bond prices fluctuated throughout the year. After a period of marked weakness during the closing months of 1930 the market showed steady improvement and at the close of the fiscal year average yields had fallen somewhat below their position of a year previously. United States Government issues showed strength throughout the year while corporate and foreign government issues tended in general to fluctuate in accordance with earnings reports and foreign political and economic conditions, respectively.

Security trading during the period under review was on a considerably lower level than during 1929–30. Contrasted with average monthly sales of 88,000,000 shares during the last quarter of the fiscal year ended June 30, 1930, the average monthly turnover during the corresponding period in 1931 was 53,000,000 shares.

The year's liquidation in the security markets was accompanied by a steady decline in brokers' loans. Loans made by reporting member banks, which stood at slightly above $3,000,000,000 at the beginning of the fiscal year, receded to $1,479,000,000 on the last reporting date of June, 1931. Total loans to member firms of the New York Stock Exchange, as reported by the latter, fell from $3,728,000,000 to $1,391,000,000 during the same period. The greater decline in the second group of reported loan figures indicates that there was a marked degree of liquidation on the part of private bankers, foreign bank agencies, and nonbanking lenders. The steady decline in the total volume of brokers' loans in the face of periodic price advances suggests that securities were tending to pass more and more into nonspeculative hands.

Money rates at the close of the past fiscal year were distinctly favorable to business revival. During the year two consecutive reductions brought the rediscount rate of the Federal Reserve Bank of New York down to 1½ per cent. The other reserve banks had in effect on June 30 rates of either 2½ per cent or 3 per cent. During the year call money rates fell from an average of 2.62 per cent to 1.50 per cent. Time loan rates ranged from 1½ per cent to 1¾ per cent while the commercial paper note stood at the end of June at 2 per cent as contrasted with a rate of 3½ per cent at the close of the 1929–30 fiscal year.

New capital issues, especially those in the form of common stocks, fell below the level of the previous year. Although the total for the closing month of the fiscal year was only $251,000,000, the fluctuations from month to month covered a wide range and during both July, 1930, and March, 1931, new issues were in excess of $500,000,000. If corporate issues are omitted, the total of new financing during the year compares favorably with that of other recent years. Total long term and short term issues of municipalities during October, 1930, were the highest for that month since 1924, and the authorizations in the November elections of State and municipal issues for public construction and for development of public works represented a record total.

Loans on securities by reporting member banks, which stood at $8,435,000,000 at the beginning of the last fiscal year declined to $6,746,000,000 during the succeeding 12 months. This represented a reversal of the trend during the preceding year when loans on securities had increased approximately $675,000,000. "All other" loans of reporting member banks experienced a relatively small decline of 7 per cent, but, it must be added, the changes in this item were influenced during the past year by the large holdings of bankers' acceptances which are included in the reported figure.

Total bank debits which aggregated $840,000,000,000 during 1929–30 fell to $563,000,000,000 during the fiscal period ending June 30, 1931. A relatively large part of this decline was due to a drop of 40 per cent in New York City bank debits and was apparently more closely related to security liquidation than to the recession in commercial activity. Bank debits outside New York City, which are a fair measure of general commercial activity, showed a drop of only 28 per cent and represented a total which was only slightly below the aggregate for such active business years as 1925–26 and 1926–27. A great part of this drop was due to a decline of more than 19 per cent in wholesale prices during the fiscal year rather than to recession in the actual volume of trade.

Outstanding bankers' acceptances at the end of the fiscal year were $63,000,000 in excess of those reported at the close of June, 1930. This increase in the face of a marked decline in wholesale prices and in foreign trade was accounted for largely by the extraordinarily low bill rates which have prevailed during the year. Throughout the entire 12-month period American banks extended large short-term advances in the form of acceptance credits. A feature of the acceptance market at the close of the fiscal year was the support given the market by the accepting banks themselves, a fact evidenced by the relatively small proportion of the total bills outstanding held by the Federal Reserve banks for their own account and for the account of foreign correspondents. More than $1,000,000,000 of the $1,368,000,000 outstanding at the end of June was in the hands of "outside" investors.

Net gold imports for the fiscal year amounted to $296,600,000. Net releases from "earmark" amounted to $83,000,000. Until the final month of the period here reviewed gold placed under "earmark" had slightly exceeded releases from "earmark," but during June the financial crisis led to heavy releases totaling $92,300,000. Total monetary gold stocks in the United States rose during the year from $4,533,000,000 to $4,958,000,000.

The public debt at the end of the fiscal year just closed stood at $16,329,000,000 or $461,000,000 higher than on June 30, 1930. Although further retirement was halted, the present debt outstanding represents a decline of 35 per cent from the postwar peak of $25,479,000,000 on August 31, 1919.

Attention was called above to the past year's numerous bank suspensions. Many factors account for the inability of various banking institutions to meet the demands made upon them, but to a large degree the underlying conditions are identified with the depression phase of the business cycle. Sharp declines in commodity prices make the payment of bank loans difficult, continued recessions in

investment values press severely on bank reserves, and general business uncertainty oftentimes tends to develop a psychological situation making it difficult for smaller banks to withstand the aggregate demands of depositors. Such factors, as is usual during depression, prevailed last year and their influence was accentuated by the effect of unusual weather conditions and widespread drought.

FOREIGN TRADE

Changes in the value of United States foreign trade during the fiscal year ended June 30, 1931, reflected the continued depression in world business. Throughout the whole period world trade was characterized by the economic chain of falling prices, reduced purchasing power, and renewed declines in export and import values. Total United States merchandise exports of $3,084,000,000 and imports of $2,432,000,000 fell below the respective totals for the preceding fiscal year by 34 per cent and 37 per cent. Compared with the average sales abroad for the 5-year period 1922–1926, the past year's drop in export values—with or without the inclusion of reexports—was approximately 29 per cent.

A large part of the year's decline in export and import values was due to the marked drop in prices. Crude materials and foodstuffs experienced sharper drops in price than did manufactured products. During the past fiscal year the average unit export values of copper, unmanufactured cotton, and wheat flour fell from 25 per cent to 35 per cent below those of 1929–30, while in the case of such products as automobiles, typewriters, and calculating machines average price declines were less than 10 per cent. If United States exports during 1930–31 are adjusted for price changes, the year's decline is only 22 per cent, and if compared with average exports during the 5-year period, 1922–1926, the total volume of sales abroad showed an increase of over 2 per cent.

Foreign trade of the United States

[Millions of dollars]

Item	Year ended June 30—							
	1910–1914 average	1922–1926 average	1926	1927	1928	1929	1930	1931
Exports of United States merchandise	2,130	4,248	4,653	4,867	4,773	5,284	4,618	3,032
Exports, including reexports	2,166	4,332	4,753	4,968	4,877	5,373	4,694	3,084
Imports, merchandise	1,689	3,646	4,465	4,252	4,147	4,292	3,849	2,432
Excess of exports (+) or imports (−):								
Merchandise	+477	+685	+289	+716	+730	+1,082	+845	+651
Gold	+17	+213	−97	−148	+498	−155	−223	−297
Silver	+20	+14	+29	+21	+20	+17	+18	+5
Quantitative index eliminating the effect of price variations (1910–1914=100):								
Exports of United States merchandise	100	132	148	175	174	193	173	135
Imports	100	155	170	180	184	203	200	167

Imports consisted to an even greater extent than exports of those classes of goods subject to sharp price recessions. Unit import values of copper, unmanufactured wool, raw silk, and crude rubber showed declines during the year ranging from 35 to 46 per cent. Reduced to a quantity basis, total imports for the last fiscal year dropped only 17 per cent and were 8 per cent above the average imports for 1922–1926.

The geographic distribution of United States foreign trade during 1930–31 reflects further the nature of the factors underlying reduced world purchasing power. Exports to Europe, which totaled $1,523,000,000, declined slightly less than 30 per cent below their value of 1929–30, whereas the values of our sales to non-European areas showed recessions ranging from nearly 60 per cent in the case of Oceania to 32 per cent in the case of Asia. The value of exports to Canada fell approximately 35 per cent, while sales to Cuba dropped 43 per cent in value. The declines in the values of exports to South America were sharply influenced by a 50 per cent shrinkage in the value of purchases by Argentina and Brazil. Our exports to European countries dropped by varying degrees, 14 per cent in the case of those to Soviet Russia and 45 per cent in the case of those to Italy and Greece. The decline in sales to Europe was materially influenced by the fact that foodstuffs and crude and semimanufactured materials, the prices of which underwent sharp recessions, constitute approximately three-fifths of our total sales to the Continent.

United States imports from Europe during 1930–31 showed a value decline of 39 per cent, whereas purchases from all other areas combined fell 36 per cent. Sharp declines in the value of imports of such colonial products as long staple cotton, burlaps, and tin, and sharp reductions in our purchases of leather and leather manufactures, linen goods, wool manufactures, works of art, diamonds, and various other articles led to marked reductions in our imports from both the United Kingdom and other European countries. Reduced purchases of newsprint, wood pulp, lumber, and copper from Canada; sharp drops in imports of hides and skins, raw wool, and meat products from Argentina; reduced shipments to us of copper and sodium nitrate by Chile; sharp declines in the value of coffee imported from Brazil, due to price declines rather than to smaller quantities; value declines of Japanese silk purchases, despite a 10 per cent increase in the quantity imported; and the combined effects of severe drops in the price of crude rubber and a slight decline in the quantity purchased from British Malaya, all reflect representative influences operating during the year in our principal import markets.

Foreign trade, by countries and economic classes

[Millions of dollars]

	Year ended June 30—							
	1910–1914 average	1922–1926 average	1926	1927	1928	1929	1930	1931
TOTAL EXPORTS, INCLUDING REEXPORTS OF FOREIGN MERCHANDISE								
To—								
Europe	1,350	2,253	2,331	2,394	2,322	2,397	2,173	1,523
All other continents	816	2,079	2,422	2,575	2,555	2,977	2,521	1,561
Canada and Newfoundland	320	639	708	797	871	999	830	530
Latin America	302	722	879	869	831	970	848	512
Asia	121	502	539	587	568	686	566	385
Oceania	48	146	201	216	174	193	160	64
Africa	25	69	94	106	111	129	116	71
EXPORTS OF UNITED STATES MERCHANDISE								
Foodstuffs	421	946	780	877	824	806	658	457
Raw materials	713	1,194	1,301	1,321	1,174	1,239	1,031	725
Semimanufactures	342	555	635	694	714	730	636	405
Finished manufacturers	654	1,554	1,937	1,976	2,062	2,508	2,293	1,446
GENERAL IMPORTS								
From—								
Europe	836	1,093	1,269	1,257	1,258	1,302	1,188	719
All other continents	852	2,554	3,196	2,995	2,889	2,989	2,661	1,713
Canada and Newfoundland	119	406	476	486	492	516	487	334
Latin America	435	965	1,052	1,049	1,039	1,089	950	623
Asia	259	1,045	1,498	1,315	1,215	1,223	1,096	685
Oceania	17	57	71	59	54	57	40	25
Africa	23	80	99	86	90	104	88	46
Foodstuffs	398	849	930	968	969	971	837	591
Raw materials	595	1,400	1,905	1,651	1,541	1,510	1,309	765
Semimanufactures	307	655	796	759	746	849	785	454
Finished manufactures	389	743	834	874	891	961	918	623

The year's changes in United States exports by commodity classes ranged from a decline of 37 per cent in the case of finished manufactures to a drop of slightly less than 30 per cent in the case of raw materials. Exports of automobiles, including parts and accessories, fell 51 per cent. Machinery, photographic goods, and paper, rubber, and cotton manufactures showed material export value declines. As compared with the 1922–1926 average, United States exports of foodstuffs showed a decline of more than 50 per cent, but exports of finished manufactures, were only 7 per cent less than those of the same 5-year period.

In our import trade by economic classes the sharpest drop for the fiscal year was in semimanufactures, which fell 42 per cent below purchases during 1929–30. Imports of foodstuffs fell slightly less than 30 per cent during the year. This class is dominated by coffee and sugar, both of which declined severely in price. In quantity coffee imports actually increased 11 per cent and sugar purchases, on a quantity basis, dropped only 9½ per cent.

The excess of merchandise exports over imports for the fiscal year amounted to $651,000,000, as compared with an average of $732,000,000 during the immediately preceding 5-year period. This balance, the smallest for any fiscal year since 1926, was partly offset by net gold imports of $297,000,000, the largest net receipt of the metal in recent years.

Progress of branch factory movement.—The influence of the world-wide depression on most phases of economic activity during the last year has naturally retarded the expansion of our industries into foreign fields through the establishment of branch factories. It may be said that, with the notable exception of Canada, there has been no development of any significance since the submission of the report on American Branch Factories Abroad (S. Doc. No. 258) last January, and there is no reason to expect a resumption of activity before a general business revival takes place.

The exceptional situation in Canada, where a considerable number of branch plants, predominantly American, were established during the last year in spite of the unfavorable economic situation in that country, serves to confirm the conclusion of this department in the report to the Senate that the tariff policies of foreign countries constitute the most important single factor in the expansion of our industries beyond the boundaries of the country. The upward revisions of the Canadian tariff by the conservative government in September, 1930, and June, 1931, were definitely and officially stated to be for the purpose of encouraging the industrial development of the country; the success of the protectionist tariff policy, as evidenced by the establishment of new American branch plants, has been repeatedly stressed by the leaders of the Government during the tariff debates. In addition to increasing the rates of duty on a considerable number of commodities, the Canadian Government has also made certain changes in the drawback regulations and the methods of fixing the basis for ad valorem duty with a view to increasing the advantages of the domestic industry. A contributing factor is to be found in the intensive campaign in favor of Canadian products carried on by the Government in connection with the upward revision of the tariff. According to a statement by the Premier on June 1, 1931, 87 new foreign branch plants, including 74 American, had been established in Canada since August, 1930. No information is available as regards the amount of investment involved.

It is of interest to note that while in the case of Canada the upward tariff revision has proved successful in attracting foreign industrial capital, a similar, but even more drastic, policy in Australia has so far failed to produce the desired results, primarily on account of the uncertainty connected with the economic policies of the country.

ELIMINATION OF WASTE

Many of the activities of the agencies functioning under the auspices and authority of the Department of Commerce are of importance in the general campaign aimed at the elimination of unnecessary waste. Prominent among these activities from the point of view of waste elimination are those relating to the production, distribution, and utilization of manufactured commodities, and to the operation and control of equipment involving hazards to life and property.

Mechanical equipment which is capable of functioning but which remains idle, and laborers willing to work but remaining unemployed, represent definite economic loss. In the elimination of waste of this kind the Department of Commerce has been especially active.

CONSTRUCTION AND HOME OWNERSHIP

The Government's program of cooperation with public and private agencies on the important problems related to the construction industry and home ownership has undergone some notable developments.

During the past fiscal year the President's Conference on Home Building and Home Ownership was announced, and is to be held in December, 1931. For more than a year the work of the committees of this conference, of which the Secretaries of Commerce and Interior are chairmen, will have been reviewing the available material, supplemented with their own surveys, on the problems of the home owner. From this, the conference may be expected to arrive at certain definite and important conclusions which may go a long way toward removing present obstacles to the building of good homes.

The efforts initiated by the President, following the decline of prices in the stock market in October, 1929, for the furtherance of which there was set up, in this department, the division of public construction, were constantly stimulated by this division.

As a further development in this field, the Federal Employment Stabilization Board, created by legislation passed and approved during the last session of Congress, has been set up in this department, with the Secretary of Commerce as chairman, to cooperate with the various construction agencies of the Federal Government in the preparation of long-range plans for public works.

While there has been a general decline in the volume of construction during the past year, undertakings in the field of public works and utilities have held up remarkably well. The construction program of the Federal Government, as is discussed elsewhere in this report, is a notable example of the practice of expanding the construction program during times of depression, and was followed by a

great number of State and local governmental agencies during the winter months of the last fiscal year, when the need for employment was greatest.

The department has kept in close touch with a new national body formed during the fiscal year, with the Secretary of Commerce as chairman, and composed of representatives of groups interested in the construction industry. It is the object of this organization, known as the National Conference on Construction, to investigate the particular points in the set-up of the construction industry that present difficulties, and to determine and promote changes in practices that will tend to stabilize construction.

Home building and home ownership.—The work of the department to stimulate home ownership, with special regard to development of sound economic policy for home owners, has been tied in with the work of the President's Conference on Home Building and Home Ownership wherever possible. The actual work on this conference was commenced early in the fiscal year.

The conference is being financed with funds contributed from private sources. However, the Bureau of Standards, particularly through its division of building and housing, has made valuable contributions in the work and research of the various committees investigating the many problems connected with home building and related subjects. Other Federal departments have been of considerable assistance in furnishing material that was needed by the committees of the conference.

Preparations for the President's conference on home building and home ownership have involved special investigations in the field or by the questionnaire method; study of the experience of business groups, civic organizations, and public departments; the compilation of the best available information; analysis of facts; and the preparation of reports to be presented at the conference.

The problems that are being studied involve the setting for the home; city planning and zoning; subdivision layout; landscape planning and planting; utilities for houses; financing; home ownership and leasing; problems of taxation in relation to housing; blighted areas and slums; reconditioning, remodeling, and modernizing; house construction—relative merits of different types of dwellings; fundamental equipment—heating, lighting, ventilation, plumbing, and refrigeration; standards for kitchens, laundries, and other work centers; household management; home making; home furnishing and decorating; farm and village housing; negro housing; relation of income and the home; organization and management of large-scale operations; and home information centers.

There has been prepared and published a pamphlet Care and Repair of the House, which makes available in compact form a great amount of information on such subjects as heating, lighting, plumbing, and refrigeration in the home, and will aid the home owner in curtailing the repair bills on the home, which amount to several hundred million dollars a year for the Nation.

The general purpose of such statistical work as that performed in the building and housing division is designed to help in stabilizing business conditions. It is an important factor in eliminating the waste due to overproduction in periods of prosperity and the unem-

ployment over periods of depression. The work on vacancy surveys is closely related to this type of elimination of waste.

The financing of homes, which has been recognized as one of the greatest problems in the field of home building, has received considerable study in the form of field surveys and research, in an attempt to arrive at some conclusions that will materially aid in providing better credit facilities for those desiring to build, and tend to stabilize property values, enabling those families desiring to build to do so on a sound economic basis.

A large amount of material has been assembled on the problem of home financing. Case studies have been made of some 5,000 mortgages. Information was sought on second mortgages, liens, and foreclosures. Losses on different types of mortgages were studied to determine the relation of loss to amount of down payment, monthly payment, and the total amount of the mortgage.

Uniformity of local building codes.—Recommendations designed to be helpful to local code committees and to bring about greater uniformity continue to be issued by the building code committee. During the year these included a report giving minimum requirements for fire resistance in buildings and a supplement to an earlier report giving recommendations for working stresses in masonry walls.

Studies that are expected to lead up to future reports including a survey of existing exit facilities in buildings and counts to determine the rate at which persons pass through doorways, down stairways, and in other locations. Extended consideration was also given to the necessary size of house drains and house sewers in plumbing systems with particular reference to high buildings.

A survey of building-code requirements in cities of 1,000 population and over by the 1930 census showed that there were approximately 1,500 building codes of various kinds in existance, ranging from very elementary requirements to elaborate consideration of all the topics usually covered. Significant of the inertia manifested in code revision was the information obtained that there are 88 cities having building codes that had not received a major revision for 20 years. Evidence of the usefulness of the recommendations issued by the Department of Commerce was shown by reports that they had been utilized in 281 cities in connection with code revision.

Planning and zoning.—An increasing demand is made for the department's services in the field of planning and zoning and a broadening of the activities is urged from many sources. Interest in regional planning has shown a rapid development in the last few years. Official and unofficial regional planning commissions or organizations have been set up in widely scattered sections of the country. There are now 68 such bodies throughout the country, whose activities cover a land area of approximately 100,000 square miles, embracing a population of close to 40,000,000.

The standard city planning enabling act, published by the department in 1927, under which States may confer suitable city planning powers upon municipalities and which also contains provisions for instituting regional planning, has been used in the legislation of 10 States.

Legislation conferring upon municipalities the power to adopt zoning regulations has been adopted by 47 States and the District of

Columbia and the constitution of the one other State, Washington, has been construed to permit the adoption of zoning ordinances. A standard State zoning enabling act, prepared by the advisory committee on city planning and zoning and published in 1923, has been used in this legislation in 36 States.

Zoning ordinances are now operative in very nearly 1,000 municipalities of the country, including 9 counties and 47 townships. Eighty-two of the 93 cities of the country having a population in excess of 100,000 have adopted zoning ordinances.

The tendency toward extending zoning beyond the limits of municipalities into rural areas through regional county and township zoning laws, as noted above, is accompanied by a growing concern about the development of areas immediately surrounding our cities. A number of municipalities have adopted subdivision regulations under a grant of extraterritorial power by the State legislature in order that new developments adjoining their boundaries may be required to conform to the city plan and avoid the makeshift and disorderly development that has been so common heretofore. This matter is now under consideration by the department's advisory committee on city planning and zoning.

A large body of qualified opinion throughout the country holds that city planning and zoning have had a salutary effect on municipal development through stabilization of uses and values of private property. It has also resulted in the reduction of huge wastes attending the improper location of buildings and public improvements and unplanned installations of public facilities, such as sewers, water mains, and paving that not infrequently occurred in the past.

Uniformity of mechanics' lien acts.—At the request of groups engaged in the construction industry and with the indorsement of other groups engaged or interested in the industry, an advisory committee consisting of representatives of the groups was appointed in 1925 for the purpose of working out in their own way the problems alleged to confront the industry in this field.

This committee has now unanimously agreed upon a draft of a mechanics' lien act, which it is believed equitably distributes among the owner, the contractor, the subcontractor, material man, laborer, and others concerned the burdens and benefits of such legislation. The mechanics' lien act committee of the National Conference of Commissions on Uniform State Laws, which has been represented on the department committee and which has cooperated with it throughout the study, is also in unanimous agreement on this draft, which was tentatively approved by the National Conference of Commissioners on Uniform State Laws at their annual meeting in September, 1931. Final action on the act will be taken by this body and by the department committee in the fall of 1932.

The task has been a large one on a controversial subject and is a notable example of the success of cooperative effort of groups with conflicting interests in a given field to solve their own problems. The act, if adopted, will no doubt have a beneficial effect in the construction industry through the correction of a number of bad or questionable practices, including an overextension of credit in reliance upon lien law security, and the use of funds provided for a specific construction project for other purposes.

DOMESTIC MARKETING SERVICE

The Bureau of Foreign and Domestic Commerce has experienced, during this past year, a tremendously increased demand for assistance from all sections of industry and trade in its work of isolating and treating the basic causes of marketing waste. At the beginning of the fiscal year it was felt that these increases had reached a point where effective administration of the work could no longer be secured in a single division. A reorganization was effected which resulted in setting up three divisions in the place of the former domestic commerce division. These divisions have been designated as the merchandising research division, the domestic regional division, and the marketing service division.

Experience has shown that the most important work which the bureau can do in the domestic field is to carry out, in cooperation with organized groups of business men, fact-finding studies which they themselves can not undertake successfully. Ample evidence is available to show the need for an unbiased research agency of this character in which business men will have confidence. The bureau has sought to merit this confidence and the large increase in the demands suggests that it has been attained in a large measure.

Along with the prosecution of such research work goes also the equal responsibility to see that the practical results of these studies are brought to the attention of the business public in such a way that they will be applied in the everyday operations of merchants and manufacturers. It has seemed useless to expend money in carrying out research work if the results are largely to lie buried in Government pamphlets which few business men know exist.

In reorganizing the domestic commerce work careful consideration was given to these two functions. Two of the new divisions established are purely research organizations. The merchandising research division carries on studies dealing with merchandising functions such as costs, credits, sales efforts, consumer preference, industrial marketing, and related subjects. The domestic regional division was set up to handle research studies having particular regional aspects. These include commercial surveys of sections of the country, trade-area studies, market data, and commodity-movement studies.

The third division known as the marketing service division has for its purpose the dissemination of the results of our own and other research in the field of marketing. Particular emphasis is placed on getting these results before the business public in such a way as to secure their practical use. This is being done through press releases, special articles, speeches, radio talks, exhibits, model stores, correspondence in answer to inquiries, and also through the stimulation of discussion programs by trade organizations, chambers of commerce, and other bodies. An effort is also being made to decentralize this work as far as possible through the use of our own district offices and through cooperation with local chambers of commerce in various parts of the country.

Efforts have also been made to develop the domestic commerce activities of the commodity divisions particularly by having these divisions act as the contact point with trade associations in their respective fields and thus to bring before such organizations the serv-

ices which the bureau can render and the results of studies in their particular trades.

In general, the work during the past year has been carried on along lines indicated in previous reports. The analysis of the comprehensive data obtained in the Louisville Grocery Survey has been completed and either published or prepared for publication. A national retail drug-store survey was undertaken with the cooperation of more than 30 national trade associations. The credit surveys have been continued and extended to cover merchandising credit. The Market Data Handbook is being revised and a series of supplements will be issued. The regional commercial survey work has been reorganized along commodity lines and several publications issued. There has been a special demand for studies in cooperation with particular trades or industries such as those undertaken for the jewelry, marking devices, blue printing, drop forging, confectionery, and other industries.

The bureau is in receipt of thousands of letters from business men expressing appreciation of the work which it is doing and of the service it has been able to render. Most of this work is of a fundamental character upon which it is impossible to place specific dollar-and-cents valuation. However, many of these letters state that the work of the bureau has enabled them to effect economies in their operations ranging from a few hundreds to many thousands of dollars. The marking-device industry has stated that the survey conducted for them was worth a million dollars to the industry. The Market Data Handbook has enabled thousands of firms to effect significant savings in marketing their products. The confectionery industry and the grocery and dry-goods trades have been especially appreciative of the work which the bureau has done for them.

The results of the bureau's efforts in this field have been especially helpful during the trying times of the past year. Many firms have indicated that by applying the results of the bureau's work they have eliminated large amounts of wasted effort and have been able to turn threatened deficits into the profit column. The bureau feels that this work which has proved itself effective in helping to eliminate many unnecessary wastes in distribution should be materially strengthened. It is one of the methods by which the Government can greatly assist in the recovery from the business depression, and its results are of benefit not only to industry and trade but in even a larger way to all consumers through lower prices resulting from more efficient operation.

SIMPLIFIED PRACTICE

In the past standards have been developed either from a technical study of the material or article under consideration, with a view to arriving at the most nearly perfect product, or on the basis of production and sale, with a view to ascertaining the variety of the article which enjoys the greatest demand. In a great many cases both methods have proved eminently satisfactory. The first of these methods, or what is commonly known as standardization based on technical or scientific research, has saved countless millions of dollars.

However, the division of simplified practice is concerned with the second of the two methods, namely, elimination of needless variety. From the point of view of the manufacturer, the selection as standard of the size or style which enjoys the greatest demand has a direct value which takes the form of dollars added to his net profits. The distributor profits through smaller inventory and greater turnover, while the ultimate consumer usually gets a better article and quicker delivery from stock. The function of the division of simplified practice is to get all parties interested in a project of this character and to coordinate their work in developing simplified practice recommendations. During the past year this cooperative work has been continued with many new industries taking advantage of the opportunities offered by this neutral agency.

Since the division was organized 10 years ago, 117 simplified practice recommendations, exclusive of 1 regional recommendation and 1 limitation-of-variety recommendation, have been accepted by industry. Twenty new simplified practice recommendations were developed by industry during the fiscal year.

A total of 38 existing recommendations were reviewed by their respective standing committees during the same 12-month period. Of these, 32 were reaffirmed, without change, for additional periods, and 6 were revised.

Surveys of production, distribution, and use were made to determine adherence to 13 simplified practice recommendations. The acceptors reporting indicated that, on the average, approximately 90 per cent of their volume of production conformed with the recommendations.

Two noteworthy developments recently observed in the application of simplified practice are an increasing interest shown by the consumers of the commodities simplified, and an extension of the practice to the field of distribution.

There are unquestionably extensive wastes in distribution, some of which can be substantially reduced through the application of simplified practice. As an example, four recommendations have recently been adopted covering wrapping and packing supplies. Similar programs for other items are under consideration. The sharpening of consumer interest appears not only as applying to existing recommendations but is also leading to the establishment of new simplification programs. For example, one simplified practice recommendation that was originated during the past year by consumers is now before industry for acceptance. Similarly, two other projects were proposed by representative users and are now being developed. This interest, on the part of the consumer, is not confined to individuals. Such national associations as those composed of purchasing agents, storekeepers, building and construction contractors, architects, department stores, groceries, and druggists, are constantly increasing their efforts to eliminate waste through the application of simplified practice.

CERTIFICATION AND LABELING

More than 15,000 requests have been received from 7,000 separate firms for listing as willing to supply material certified by them to comply with the requirements of 335 Federal specifications and 21

commercial standards. The lists of willing-to-certify manufacturers have been sent to Federal, State, county, and municipal purchasers who are spending money collected from the public in the form of taxes.

There is given in the accompanying table, a statistical summary of the willing-to-certify lists, showing the groups of commodities covered by the specifications to which the certification plan has been applied. The commercial standards referred to therein relate to clinical thermometers, plumbing fixtures, pipe nipples and unions, builders' hardware, drill fittings, gage blanks, feldspar, foundry patterns, golf shafts, wall paper, cleaning solvent, dress patterns, and men's pajamas.

Commodity groups	Total number of—			Commodity groups	Total number of—		
	Specifications	Listings	Firms		Specifications	Listings	Firms
Abrasives and polishing materials	9	113	54	Packing and gaskets	13	162	66
Brick	2	596	596	Padlocks	1	17	17
Brushes and brooms	48	945	179	Paints and paint materials	29	3,004	305
Builders' hardware	1	33	33	Paper	28	557	126
Cement, Portland	1	69	69	Pipe and pipe fittings	7	83	64
Cotton gauze and bandages	5	34	11	Refractories	3	108	60
Dental and surgical supplies	1	16	16	Ribbons, typewriter	3	93	36
Electrical supplies	14	220	153	Road and paving materials	7	121	48
Fire extinguishers and liquids	3	78	51	Roofing, bituminous and waterproofing	16	571	106
Floor coverings	5	32	19	Rope, wire	1	15	15
Glass	1	52	52	Rubber matting	1	13	13
Goggles and helmets	7	58	14	Safes, burglar-resisting	1	3	3
Heat-insulating materials	8	58	30	Scales, railroad track	1	7	7
Inks	6	114	43	Scales, weighing	1	33	33
Insecticides	3	28	18	Screws, wood	1	14	14
Leather goods	4	103	81	Soaps and scouring compounds	13	562	158
Lime and plaster	4	145	87	Tableware, silver-plated	1	7	7
Liquid-measuring devices	1	21	21	Textiles	33	598	191
Lumber	2	5,642	3,150	Towels	1	12	12
Masonry, cement, and concrete materials	5	76	71	Tubing, metallic	4	61	49
Nonferrous metals	32	1,221	327	Commercial standards	21	699	638
Office supplies	8	72	57	Total	356	15,466	7,099

The 335 Federal specifications to which the certification plan has been applied represent about one-half of the total number of specifications promulgated by the Federal Specifications Board for the use of all Federal Government departments and establishments. About 50 per cent of the specifications and standards to which the plan has been applied and nearly 60 per cent of the listings relate to building materials.

Official indorsement of the certification plan has been received not only from agencies representing Federal, State, county, and municipal governments but also a great number of other consumer groups and trade associations, especially those in the building industry. In the case of commercial standards, a majority of the general conferences of representative producers, distributors, and consumers voted formally to request the Bureau of Standards to apply the certification plan to the approved commercial standards.

The year just past has witnessed a rapidly increasing and very widespread indorsement of the self-identifying, quality-guaranteeing labeling plan, in accordance with which a firm desiring to bring effectively to the attention of the "over-the-counter" buyer at the time of making a purchase, commodities which it is willing to guarantee as complying with certain specifications and standards, places on the commodities or their containers labels definitely setting forth these facts.

The labeling plan has been formally indorsed by not only the leading organized consumer groups but by a large number of progressive trade associations, many of whom are underwriting the labels and maintaining inspection services to insure that the guarantees on the labels will be complied with.

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 brooms, dental alloys, dry cells, fireproof safes, gypsum, ink (writing, colored, and indelible), library paste, lime, linoleum, lumber, paint, paper (correspondence, carbon, blue print), pipe, Portland cement, rope, soap, textiles, and wall board.

COMMERCIAL STANDARDS

While the whole realm of present-day marketing is in a state of flux, manufacturers are meeting the modern demand for more nearly complete and accurate information on their products, and for some means of comparison or basis for judgment on the part of the customer. They realize that the purchaser of to-day distrusts his five senses as buying guides; the goods purchased are superior, or at least equal, to some recognized standard. This trend is very apparent in current advertising. It exhibits itself in the establishment of testing laboratories as adjuncts to magazines for checking or indorsing producers' claims for products advertised therein, or as the basis for "approval" insignia, and it is particularly manifest in the increased use of labels by means of which quality or grade of an article is definitely certified to the purchaser by the seller or by his trade association, sometimes both.

In addition to satisfying the consumer on the merits of a given article, the rapid introduction of new materials, processes, and inventions has brought about an increasing need for a better understanding between buyer and seller (1) as to the real significance of the terms employed to describe the product, (2) definitions or specifications for the various grades or ratings, (3) recognized methods of test, (4) dimensional standards and tolerances to provide interchangeability or to prevent skimping, and (5) any other criteria for use by the consumer as a guide to acceptance or rejection of the product.

Industries are frequently confronted by a situation brought upon them by short-sighted manufacturers who produce inferior merchandise to sell at a low price. While this price may be lower than that required to purchase the standard quality, it is frequently high in relation to value. Dissatisfaction in the use of this inferior merchandise brings discredit to the whole industry, and users are driven from the product in question to another competing product in spite

of all the leaders of the industry may do to restore public confidence in their goods. Forward-looking groups of producers have therefore found it advisable to cooperate in the formulation and promulgation of specifications and methods of test sponsored by the industry as a whole as a basis for marketing.

Cooperation in this direction has the effect (1) of pooling producer information and data, (2) of passing on to the distributor and user authoritative knowledge and expert advice on the product, (3) of promoting more efficient use, (4) of preventing misrepresentation, and (5) generally increasing the assurance in procurement and satisfaction in the use of the commodity.

Homemade specifications, used by an increasing number of contract buyers in an attempt to control quality, complicate the marketing situation. Manufacturers are forced to produce a multiplicity of varieties of their products to meet the whims of specification writers who may have no real knowledge of the commodity; mass production is interfered with.

The task of untangling the maze of conflicting terms, grades, ratings, test methods; arriving at a generally acceptable understanding thereon; and "putting it over" with the buying public seems colossal to the manufacturers and beyond the range of possibility by means at their immediate disposal. So it is but natural that many groups have sought the aid of the Department of Commerce for this purpose.

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 acceptance by a satisfactory majority and without active opposition, satisfies all phases of the situation and offers an authoritative and dependable basis for marketing and purchase by all elements directly concerned.

During the year, as a result of general conferences, wide publicity in trade papers, and general circulation for written acceptances, the success of 11 commercial standards was announced. Twelve of the standards were issued in printed form during the same period, making a total of 34 accepted commercial standards and 27 issued in printed form as of June 30, 1931.

AMERICAN MARINE STANDARDS

These standards are promulgated by the American marine standards committee as a result of nation-wide consideration within the field of the marine and allied interests. The committee was formed under the auspices of the division of simplified practice to promote elimination of waste in the construction, operation, and maintenance of ships and port facilities. As of July 1, 1931, its membership comprised about 370 member bodies, and 124 standards had been issued.

The committee is aided by facilities and services contributed by the Department of Commerce and the United States Shipping Board, but it is self-governing. An executive board is elected annually from and by the membership, which is composed of shipyards, ship repair and docking establishments, ship owners and

operators, naval architects, marine engineers, and various technical, commercial, and governmental interests related to marine industry. Advisory members are appointed to the board by the American Institute of Electrical Engineers, the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Society for Testing Materials, the Bureau of Standards, and the National Fire Protection Association. The committee cooperates closely with the American Association of Port Authorities as to standards for port facilities; also with other organizations carrying on standardization work in other fields.

SCIENTIFIC RESEARCH

Bureau of Standards.—As has been pointed out in previous annual reports, the Bureau of Standards works in close cooperation with American industries in their efforts toward waste elimination. This has been a year of greatly curtailed production, yet it is interesting to note that the requests from industries for the bureau's services have shown substantial increases in many lines and but very slight reductions in others. Apparently farsighted executives are taking advantage of present conditions to eliminate inefficiency in manufacturing processes and to acquire all possible scientific data relating to their particular industries for use when normal conditions return.

One of the most effective ways in which the bureau cooperates with industries is through the research associates stationed in its laboratories. At the close of the fiscal year there were 95 of these associates, representing 47 individual manufacturers or industrial groups, working on a wide variety of problems. These figures compare favorably with 96 and 41, respectively, for the previous year.

A valuable service which the bureau renders is the testing of materials, instruments, and appliances for the Government and under certain conditions for the public, to determine compliance with specifications. The total number of such tests conducted during the year was 212,717 with a fee value of $816,979. The corresponding figures for the previous year were 200,726 and $683,614, respectively.

An important development was the satisfactory realization of an exchange arrangement between the Bureau of Standards and the Physikalisch-Technische Reichsanstalt of Germany by which Dr. F. Henning was sent to Washington for two months' work on the absolute standard of light and on temperature measurement, while Dr. G. W. Vinal spent some time in Berlin in carrying out comparisons of the fundamental electrical standards.

In connection with this international cooperation it is interesting to note that a standard which the bureau has advocated for a long time has now been adopted by the International Committee on Weights and Measures; that is, a temperature of 68° F. as an international standard for all industrial length measuring instruments. This will be of the greatest importance in eliminating confusion and waste in shop procedure all over the world.

Since 1914 the bureau has worked with the railroad systems of the country in helping to raise the standard of performance of railroad track scales upon which the charges for revenue freight are

based. The number of these scales tested by the bureau's special equipments during the year, 1,030, is the largest on record, and the percentage of correct scales shows a small but satisfactory increase. As in the case of the manufacturing industries it is gratifying to know that at a time when scale maintenance might have been expected to drop somewhat in efficiency, the carriers are increasing their efforts to improve scale performance.

The American Electric Railway Association is supporting a project at the bureau, as the result of which the efficiency of the driving mechanism of street cars will be increased and noise reduced. The gearing, methods of suspension, and the arrangements for lubrication are receiving intensive study.

In the color printing process considerable waste results from misregister, which produces an overlapping of the various colors in the finished print. At the bureau, methods for controlling dimensional changes in electrotypes are being investigated as well as the causes of changes in the paper.

Paper manufacturers and allied industries have worked with the bureau for many years and recently particular attention has been paid to ways for increasing the life of paper. The importance of using highly purified fibers in the manufacture of paper for permanent records has been brought out, and it is evident that the degree of purification rather than the source of fibers is the important point to be considered. A survey was completed of atmospheric conditions in libraries where valuable books and records are stored in stacks. It was found that some important deteriorating influences had been largely overlooked, namely, humidity and acidity of the atmosphere. Sulphuric acid present in the atmosphere of large cities has been found to be one of the principal causes of the rapid destruction of paper. Treatment to neutralize this acidity will remedy this difficulty.

Of particular interest to the Army and Navy, but also to those concerned with commercial aviation, is the development by the bureau of a satisfactory cotton cloth for the making of parachutes. This investigation, which has just been brought to a satisfactory conclusion, was undertaken primarily to discover whether cotton could be used in place of silk in case of a war emergency. The bureau has found that this is entirely practicable and it has been able to make a cloth which meets all the military requirements.

The testing of all sorts of building materials is an important function of the bureau. This work includes chemical analyses, strength tests under all varieties of conditions, fire tests, and field inspections. Thus data have been secured on the durability of slate from practically every important slate-producing district in the country. Fire tests have been carried out on special wood partitions suitable for the interior trim of high-grade offices, steamships, etc., and on a new design of steel floor construction. In cooperation with the Federal Fire Council and the National Fire Protection Association conditions in Government buildings have been studied and recommendations made which will lessen the fire hazard.

The services of the cement reference laboratory, maintained jointly by the bureau and the American Society for Testing Materials, have been in constant demand. Field inspections were made in 122 labora-

tories and requests have been received for 196 more. Uniformity in testing procedure will result from this work, with a consequent elimination of waste.

At the bureau's cement laboratory in Washington and at its three branch laboratories 2,311,000 barrels of cement were sampled, an increase of 42 per cent over last year.

Additional studies have been made of welded steel members for buildings, bridges, ships, and other structures. Reliable engineering data on the strength of welded joints will help to spread the use of this method of fabrication, as it has been proved that it possesses many advantages, such as cheapness and freedom from noise.

The study of the corrosive action of soils on specimens of pipe and protective coatings has been continued in cooperation with the American Gas Association and interested manufacturers. The importance of surveying soils through which a new pipe line is to pass has been brought out, since no one class of pipe material or protective coating has been found best for all conditions.

As has been the case during every recent year the demands of the radio industry have called for more and more accurate standards. The necessity for the close control of radio frequency is such that the bureau maintains its basic standard of frequency with an error of only 1 part in 10,000,000. A new series of standard-frequency radio transmissions was inaugurated in January. These are accurate to better than 1 part in 1,000,000 and can be heard and utilized over practically the entire country.

In the past, imperfect castings have been a frequent source of loss to foundries. Part of the trouble comes from the lack of fluidity of the metal which refuses to flow into the remote spaces in the mold. A method has been developed for measuring the fluidity of metals in casting, and by making certain tests under specified conditions in the foundry it will be possible to tell in advance whether a satisfactory job can be turned out.

A source of danger in the operation of airplanes and of annoyance to motorists is vapor lock or the formation of bubbles in the fuel line. This usually stalls the engine and under certain conditions may result in loss of life. The bureau has found that vapor lock can be largely eliminated by careful design of the fuel system and recommendations to this effect have been published. It is expected that the new models of automobiles will reflect these recommendations in the arrangement of their power plants.

The new national hydraulic laboratory in which the flow of water in channels, over dams, and in turbines can be studied will soon become an accomplished fact. The designs for the building and equipment were approved by the advisory committee early in the spring and the concrete work has already been completed. It is expected that the laboratory will be in operation during the coming fiscal year.

UTILIZATION AND CONSERVATION OF NATURAL RESOURCES

Mineral.—The Bureau of Mines maintained during the fiscal year 1931 its program of investigations concerning the location and conservation of resources of natural helium-bearing gases and added very materially to its store of information on the subject. Notable

advances were made in increasing the efficiency of helium production in the Bureau of Mines helium plant near Amarillo, Tex. An average cost of $10.36 per thousand cubic feet for helium was affected for the year, covering the operation of the plant and the source of gas supply; and during one month of the year the record low cost of $5.95 per thousand cubic feet was reached.

Products of the soil.—The industrial utilization of farm wastes has been greatly extended through practical studies by the Bureau of Standards in cooperation with Iowa State College, Alabama Polytechnic Institute, and the University of Alabama.

The 100,000,000 tons of cornstalks commercially available but wasted annually in the United States have received most attention as a possible means of farm relief. The whole stalks are cut into short lengths, cooked with water, washed, shredded, beaten, sized, and run onto a machine for removing the water and forming a porous board and then drying it in a continuous operation. Insulating boards with varying porosity and a thickness from one-half to 1 inch are easily made with this machine and found equal to any commercial product. Work is being continued on the improvement of the water-proofing and fire-resistant properties of these boards. The board-forming machine was designed, constructed, and tested in a semicommercial size and operation, and has been adopted and used very successfully by a commercial firm for this purpose. This company, upon organization, employed the bureau staff responsible for the semicommercial developments who are now manufacturing daily 60 to 80 tons of cornstalk wallboard. One trainload was used for insulating the Chicago World's Fair buildings. The company employs about 75 men and has paid farmers over $200,000 for cornstalks in one year, or more than the entire United States Government appropriations in four years for this work. About half of the wallboard is fabricated in very porous form, used in refrigerators, and the rest is grooved for making flat insulating walls and linings for ceilings. The board can be painted or plastered in smooth finish or covered with wall paper. A machine is being developed for harvesting the cornstalks, shelling and sacking the corn, and baling the stalks in one operation in order to enable farmers to have employment in collecting and selling cornstalks in fall and winter months.

Pressed board or cornstalk lumber is formed by hot-pressing the porous board into a dense tough sheet without any grain. Sheets about 0.06 inch to 0.1 inch thick have been made for use as bookbinder board and found to be about three to four times as strong as standard commercial materials. Service tests are under way. When impregnated with synthetic resins and hot-pressed, these boards have great strength, beauty, and finish desirable in making table tops, wall panels, and furniture. A number of complex forms of articles have been successfully molded, and manufacture of window frames, chair seats and backs, boxes, electrical fixtures, and dimension lumber will be studied.

Maizolith is a tough, horny product like hard rubber. It is made by purifying cornstalk fibers, beating them into a gel and molding and drying and machining it in the form of slabs, tubes, rods, and other shapes. Work is being continued on the rate of drying, shrinkage, aging-strength relations, waterproofing, cost data, and other important factors.

Wheat straw has been converted into a strong kraft paper pulp in 45 per cent yield. Economical methods of bleaching have been developed and conversion of the pulp, with or without other fibers, into paper is under investigation.

Cooperative work has been continued on the purification of xylose from cottonseed hull bran and its use in human diets and in several commercial products. Medical authorities report that it is nontoxic, and one cooperator reports that it may be useful in treating Bright's disease. The University of Alabama has made promising varnishes from xylose and aniline.

Sweetpotato starch has been found suitable for sizing textiles and can replace certain imported materials. It can be produced economically in the South from cull sweetpotatoes. Semicommercial production of the starch and sizing is under way for use in practical tests on textiles in cooperation with the Alabama Polytechnic Institute. Industrial textile mills are interested and have offered cooperation in plant scale studies.

The chemical reactions involved in the kraft pulp process are being investigated in a semicommercial cooperation with the University of Alabama. The kraft pulp cook gives rise to very pungent mercaptans whose odors are obnoxious and injurious to the community. The study is developing means for the recovery and commercial use of these mercaptans to avoid this public nuisance with possible profit to the pulp company.

The production of edible oil and laundry and white soap from crude cottonseed oil has been developed for household use on the farm. Certain further refinements of the process have been worked out to enable local oil mills to refine their own oil to supply local markets with soap and high-grade, colorless cooking oils. The mills now operate only four to six months annually and would thereby give employment to local labor during a large part of the year, cut down overhead on the plant, and save freight on the products. At the request of a commercial firm an investigation of a continuous process of solvent extraction of oil-bearing seeds has been made to see whether high-grade oil and protein meal suitable for human food can be produced economically. The process seems very promising and could be employed economically in local oil mills.

The Departments of Commerce and Agriculture and several commercial firms were requested by the United States Committee on the French Colonial Exposition in Paris to prepare a pictorial exhibit showing progress in the United States on the industrial utilization of waste farm products. A model was made showing a cotton farm, factory, and commercial laboratory, the cotton being picked and hauled to the factory, and the products issuing from it. On account of the limited space the model showed only about 50 products made from cottonseed. Exhibits of products from fruits and vegetables and of insulating board from agricultural fibers were included. The Department of Commerce has been informed from various surces that this exhibit is attracting considerable attention.

Several articles and bulletins have been published and others are in preparation on the development of these semicommercial processes and on analytical methods employed in the researches.

The object of these researches is to make marketable products from farm wastes, develop commercial processes for their manu-

facture, study economic factors involved in the collection, transportation, and processing of raw materials and marketing of finished products. In carrying out this work the Departments of Commerce and Agriculture are cooperating to make sure that there will be no duplication of efforts. It is believed that a steady expansion of this program will result in a valuable means of farm relief.

Fisheries.—Through its technological research, the Bureau of Fisheries constantly is developing new by-products from the waste or refuse of the various fishery food industries and is finding new uses for old fishery products and by-products.

For the past several years chemical and engineering studies have been made of methods of manufacturing fish meal, fish oil, and other by-products of the fisheries. The aim of this work is not only to improve existing methods of production but to devise from time to time new machinery and new methods of production. A constant improvement of the finished product is the result of better manufacturing methods. Such improvements in the quality of the finished product mean higher quality markets and a resultant increase in their economic value to the country. A concrete example of this is the transition of dehydrated fish waste from fertilizer stock to fish meal for animal feeding, and a further and more recent development of fish flour for use in the human dietary from the edible waste of the fisheries. The bureau's production studies have brought out an important fact that both the degree and duration of heat in the manufacturing process adversely affect the nutritive value and general quality of the finished product. These studies have further substantiated the knowledge that excessive heat and oxidation tend to destroy certain nutritive properties of most foods.

Nutrition research by the bureau is opening new markets for many of our fishery products. For example, investigations of domestic fish oils have shown that these oils, which formerly had to depend on such industrial uses as the manufacture of soaps, etc., for a market, contain sufficient quantities of vitamins A and D to replace imported cod-liver oil in both human and animal nutrition. Improvements in the method of manufacture of these domestic fish oils will expand such markets. Other nutrition studies of the bureau are demonstrating the nutritive value and possibilities in specialized use of many marine products. Experiments in the preservation of marine products from the chemical, engineering, and bacteriological standpoints are expected to improve constantly and to develop attractive food products of the fisheries at increased economic value to both producer and consumer. The principal methods of preservation are refrigeration, canning, smoking, salting, and dehydration. By making use of and studying experimentally these general methods of preservation, it is hoped to improve the nutritive value, palatability, and keeping qualities of the various products of the fisheries.

The bureau is also making scientific investigations of the efficiency of certain chemicals in prolonging the useful life of fishing nets and gear. From time to time, certain chemical formulas have been devised which have a marked preserving effect. Publications have been issued recommending these formulas, describing methods of preparation of these chemical treatments and the most efficient means of

applying them to nets. Wherever these formulas have been used upon the recommendation of the bureau, marked improvements in the preservative effect on the nets and gear of the fishermen have been demonstrated.

An effective policy for the conservation of the fisheries of Alaska is being prosecuted by the bureau under the law which gives it control of commercial operations. A close check on such activities and careful observations of the volume of the salmon runs are constantly exercised for the purpose of regulating fishing to permit the escapement of at least 50 per cent of the runs for brood fish. Where it is apparent that a particular run has become depleted, fishery operations are further curtailed in order that the future supply may not be impaired as a result of inadequate seeding. On the other hand, restrictions are modified promptly when the situation warrants. Biological studies of the life history of the salmon and other valuable food fishes are conducted, and exhaustive analyses of statistical data are made with a view to applying scientific knowledge to the practical end of enlarging and stabilizing the industry. The results achieved have been gratifying, and there is reason to believe that the yield of the fishery resources for future generations may be maintained at a higher level than the present liberal harvest.

The artificial propagation of fish as conducted at Federal hatcheries comprises both the husbandry and the conservation of a natural resource. The latter aspect is emphasized by the practice of securing eggs from commercial species caught for the market and subsequently incubating them and distributing them from the hatcheries.

Fishery resources are further augmented by the stocking of fish derived from domesticated stock maintained at the hatcheries or by the collection of eggs from wild fish with the consequent reduction in mortality achieved by hatchery rearing in place of dependence upon nature. More complete utilization of existing hatchery facilities, together with improvement in technical methods looking toward the reduction of the mortality, is one of the most potent means whereby conservation is achieved; and the ultimate object of insuring a greater number of mature fish in the streams is furthered.

As a result of extensive experiments improvements in the efficiency of fishing gear are being developed, which promise to become an active factor in the conservation of fish through the elimination from the commercial catch of undersized or immature fish taken and destroyed in tremendous quantities in ordinary commercial fishing operations. These studies have demonstrated the proper size of mesh for gill nets and pound nets in the Great Lakes which will liberate undersized fish without reducing the catch of commercial sizes, and similar success has been attained in perfecting the otter trawl used in the haddock fishery of the North Atlantic. The use of such improved gear will be an important factor in the conservation of the fish supply and, moreover, will permit economies of operation.

Increased utilization of the natural supply of food fish in the sea results from predictions of the variations in abundance. During last season the great abundance of mackerel in the North Atlantic fishery was foretold early in the spring, and similar predictions of abundance have been issued for the current season, thus permitting the industry to make preparations to harvest and distribute the crop to better advantage.

Wood utilization.—The National Committee on Wood Utilization has carried on a number of projects, the object of which has been the elimination of waste in the manufacture, distribution, and consumption of wood products.

Early in the year the committee issued a booklet entitled "How to Judge a House." This manual, prepared under the guidance of a subcommittee of nationally known building authorities, contains practical hints and advice concerning the various problems confronting the home buyer or renter. It has proved to be one of the most popular of the committee's publications, more than 75,000 copies having been sold.

The committee is now compiling a report on Wood Construction in the Tropics, in which will be included the latest data on proper methods of preventing damage from decay and insect attack, with a résumé of good construction principles.

A handbook on roof designs for airplane hangars and similar structures is being developed. In this booklet careful consideration will be given to latest types of construction on which the committee is making cooperative studies at the Forest Products Laboratory on metal-joint connectors, and at the University of Illinois on glued laminated wood arches. The basis for the report on airplane-hangar construction will be the fire tests conducted at the Bureau of Standards during the spring of 1930, under the auspices of the fact-finding committee on automatic-sprinkler protection for airplane hangars. The National Committee on Wood Utilization participated in these tests.

The committee's project on the utilization of discarded wooden containers and odd pieces of lumber was continued. More than 200,000 copies of the first two volumes of the You Can Make It series have been sold. Several States, in cooperation with the committee, sponsored wood-utilization contests, the winners of which were given free trips to Washington, D. C. The manuscript of a new bulletin entitled "You Can Make It for Profit" was sent to the printer during the latter part of the fiscal year.

For the purpose of assisting the nontechnical consumer in judging furniture values, the committee published a book entitled "Furniture: Its Selection and Use." This book appropriately illustrated how to select home furnishings economically and efficiently without sacrificing quality of manufacture or beauty of design.

In view of the large number of insulating products made from wood and wood fiber, the committee has just prepared a bulletin entitled "House Insulation: Its Economies and Application." This booklet is intended as a ready reference manual for architects, builders, and contractors, as well as the prospective home builder who desires authoritative information about insulating materials and their proper use and application in house construction.

The committee has continued its activities in the treated wood field and has extended its program sponsoring the retail distribution of treated wood to several other States than Ohio, where the program originally was launched, in order that supplies of the material might be generally available to small consumers, thereby assisting them in reducing upkeep and repair expenses and prolonging the life of their houses and buildings.

The committee inaugurated in New York State the fourth of its series of State surveys of nonutilized wood. Information regarding the kind, quantity, and location of wood waste in the State will be tabulated and published, based on returns received from approximately 4,000 sawmills, woodworking and wood-using plants. The third of the State survey series has been completed in Maryland. The report is now in press and will show the distribution and sources of supply of approximately 5,000 carloads of wood waste.

A detailed study of the economies of using cut-to-size small dimension stock in the various wood-fabricating industries, such as automobile bodies, furniture, sporting goods, and wood turning, has been completed and will probably be issued during the coming year. The object of this study is to decrease waste in the wood-fabricating industries and to encourage the close utilization of raw material at the sawmill.

HUMAN SAFETY

In mining.—In making recommendations on standard mining practice to the mining industry the Bureau of Mines bases its formal decisions on the findings of its mine safety board, which is made up of representatives of the different technical divisions of the bureau.

Much information of value in solving problems confronting mine operators is being developed by the Bureau of Mines. In this bureau's experimental mine the relative explosibility of coal-mine dust from different mines of the country is tested from time to time to ascertain the proper means of preventing coal-dust explosions. Tests are being made of the factors in general rock dusting for the prevention of coal-dust explosions, for the purpose of modifying the code on such dusting formulated by the Bureau of Mines and approved by the American Standards Association.

Electrification of the coal-mining industry has created new hazards. The bureau is constantly conducting tests of various types of electrical equipment used in mines with a view to the development of "approved" designs that eliminate these hazards as much as possible. As faultily designed miners' lamps have caused many mine explosions, the bureau has led the way in the development of "permissible" lamps which are far safer than those previously used. The permissible type of explosive, the use of which is rapidly being extended throughout the mining industry as a result of the bureau's tests and educational campaign, is also much safer than other types of explosives.

With a view to complying with regulations for the operation of coal mines on the public domain, the Bureau of Mines and the Bureau of Standards are carrying on a cooperative investigation relating to the strength of mine stoppings that will resist explosions.

Definite routine tests to determine the safety of gas masks when worn in known concentration of various mining and industrial gases have been adopted by the Bureau of Mines. The bureau has conducted courses of instruction in standardized methods of mine-rescue procedure and has given demonstrations in the proper use and limitations of rescue apparatus. Its handbook on self-contained mine-rescue oxygen-breathing apparatus has been revised, enlarged,

and reissued. Its manual of instruction in first aid has also been revised, enlarged, and reissued.

For a number of years the bureau has fostered the holding of a considerable number of contests to encourage the training of miners in methods of first aid to the injured. More than 100 of these contests are now being held annually with the cooperation of the Bureau of Mines personnel and more than 110,000 persons engaged in the mining and allied industries are taking the full standardized first-aid course as given by the personnel of the Bureau of Mines.

A new course in accident prevention in bituminous coal mines has been formulated, and is being taught in various parts of the United States, chiefly to officials; the course requires several weeks' time and in its first year has been taken by nearly 2,000 coal mine officials.

Experience has shown that safety in industry is materially advanced by having a definite safety organization at every plant. In order to aid in having a safety organization at every mine the Bureau of Mines has formulated a suggested type of safety organization applicable to any kind of mining plant. In addition the Bureau of Mines is aiding in the establishment of chapters of the Holmes Safety Association at mining communities to help in making the safety organization effective in the mining town as well as in and around the mine.

One of the more recent of the activities of the Bureau of Mines is a field study of mine lighting with a view to establishing standards by which the mine worker will have sufficient light to allow of safe efficient work rather than work more or less in the dark as in the past. These studies while yet in their infancy reveal that the mine worker frequently has less than 5 per cent of the amount of light that most other industrial workers have.

The factory and the home.—The Bureau of Standards is active in the work of the safety code correlating committee and cooperates in the formulation of various industrial safety codes. It is a sponsor for the National Electrical Safety Code, American Logging and Sawmill Safety Code, National Safety Code for the Protection of Heads and Eyes of Industrial Workers, Code for Protection Against Lightning, Safety Code for Elevators, Dumbwaiters, and Escalators, Gas Safety Code, and Code for Automobile Brakes and Brake Testing, all of which are subject to periodical revision. During the year attention was given to revising the National Electrical Code and the Code for Lighting School Buildings, and text was prepared for an elevator inspectors' handbook.

An analysis was made of records of low-voltage electrical accidents, which showed that a majority of the domestic fatalities resulted from the use of defective portable cords or portable appliances and most of these occurred in the bathroom, due to wet conditions. Home safety demonstrations were given at Scranton, Pa., and Greenville, N. C., in connection with meetings of State Federations of Women's Clubs.

By sea and air.—The radio division, through its supervisors of radio stationed at the principal seaports, enforces the radio law requiring radio apparatus and radio operators on all foreign and American vessels navigating the oceans and the Great Lakes where

such vessels carry 50 or more persons, including passengers or crew, or both, and run a distance between ports of 200 miles or more. This branch of radio inspection work, having for its purpose the safety of life and property, receives first consideration.

During the fiscal year just ended there were reported 15,408 clearances of vessels coming under the radio act referred to and during the same period 11,433 inspections were made.

In furtherance of safety at sea and in the air, the Lighthouse Service has made many changes and improvements in the aids to navigation. A new light station, which has been under construction for two years is now nearing completion in the St. Marys River connecting Lakes Superior and Huron. This station, at Detour, Mich., will replace an older one built on the shore some distance from the track of vessels. Another station of major importance is under construction at Anacapa Island, Calif.

During the year, three new lightships, of a new and improved design, have been placed in commission, replacing older vessels. On these ships Diesel electric power is utilized both as a means of propulsion and for operating the masthead light, fog, and radio signals.

The effectiveness of the radiobeacon system has also been increased, 12 new beacons being established, bringing the total up to 90. Of these 68 now automatically broadcast their signals hourly. A recent development, which has proved a valuable additional aid to mariners, is the synchronizing of the fog signals and radiobeacon signals in order that vessels may quickly determine their distance from the sending station. Sixteen such distance-finding stations are now in service.

On June 30, 1931, there were 20,273 marine aids to navigation maintained by the Lighthouse Service, a net increase of 711 over the previous year.

Improvements in airways facilities included the lighting of about 2,283 additional miles of airways, the construction of 13 airway radio-communication stations, erection of 43 aural type and 2 visual type radio range beacons, a number of radio-marker beacons, and the installation of telephone-typewriter circuits aggregating over 3,000 miles in length.

The number of radiobeacons operated by the Lighthouse Service has increased during the past year, as has the number of radio compasses. There is a total of 90 radiobeacons in operation at the present time, divided as follows: Atlantic coast, 26; Gulf coast, 9; Pacific coast, 21; and Great Lakes, 31. This is an increase of 12 stations over last year.

The number of commercial and Government ships under the United States flag equipped with radio compasses on July 1, 1931, was 1,334. There are 3,553 foreign vessels so equipped, as compared with 2,285 last year.

The activities of the Coast and Geodetic Survey since its inception during the presidency of Thomas Jefferson in 1807 have aided human safety in many ways, and to-day either directly or indirectly affect almost every scientific and engineering endeavor. It has been progressive in constantly improving methods and appliances, and its

standards and specifications in hydrographic and geodetic theory and practice continue to be adopted by other nations.

With precision the watchword, its records are accepted with confidence as accurate and official, and they cover nautical charts, airway maps, predictions of tides and currents, currents diagrams, information on ocean depths, variation in sea levels, oceanography, the size and shape of the earth, earthquake investigations, manuals on various kinds of surveying, the exact geographical locations and elevations of thousands of points throughout the United States, compass variations, aurora observations, isostasy, control surveys, and many related subjects.

The nautical chart, probably the best-known product, is an essential equipment of every vessel, large and small. It is interesting to note the vast changes that have occurred in these charts, the requirements of the speedier motor-driven craft of to-day over the leisurely moving sailing vessels stipulating an exactness of detail previously as unattainable as it was unnecessary. Many of the larger vessels of to-day carry a passenger list and represent a money investment of a size that probably would not have been believed possible at one time. They operate on schedules making no allowance for fogs, shoals, and other navigational menaces. However, with a modern chart showing the configuration of the bottom in detail, the mariner without reducing speed fixes his position from underwater landmarks listed, by means of an electrical depth-registering device, just as he uses visible features on approaching land, all shown on charts.

Further safety aids to the mariner in maintaining his schedule include the published predictions of tides and currents and current charts issued for certain of the important harbors with congested traffic. In other words, the mariner of to-day realizes that as a further insurance against loss of life and property he needs not only the nautical charts and their accompanying Coast Pilots, giving other data with respect to ports, harbors, and natural features, all of which can not be portrayed on the charts, but he utilizes as well the available accurate data of the velocity and direction of the current and the time of occurrence of slack water published with respect to congested ports where swift and dangerous tidal currents exist.

Charts of the Atlantic and Gulf coasts must not only show details correctly with respect to that region, but they must be geographically placed with respect to their relations or positions to charts of the Pacific coast, as well as maps of the intervening territory. This is accomplished by means of a control survey which, while not in itself a map, furnishes a rigid framework upon which maps and charts are properly built. At thousands of selected points or stations throughout the United States the Coast and Geodetic Survey determines the exact geographical position, which is marked with a metal disk embedded in solid rock, or heavy block of concrete, for permanency. With stations separated by no more than 50 miles, local surveyors can without undue expense survey near-by areas after ascertaining from the bureau the exact position of the particular station used. In the same way, these thousands of stations will properly place, so they may be brought together into a large map and fit, individual maps of cities, counties, States and

countries, lakes, rivers, and islands, and the Atlantic, Gulf, and Pacific shore lines.

The Coast and Geodetic Survey also issues specialized maps prepared for the use of aviators. These airway strip maps, covering established airway routes, and the airway sectional maps, a series of 92 of which will eventually cover the entire United States, are produced in colors and show airports, radio ranges, revolving and flashing beacons, prominent high-tension lines, various lighthouses, streams, lakes, railroads, towns, elevations, and other features of importance to the pilot of an airship.

Both charts and maps contain information on the variation of the compass, in the form of "compass roses," on which the direction of the magnetic north, or the direction indicated by the compass, is shown in its relation to the true north. With the annual variation shown, the mariner or pilot can make allowance for the change between the data of his chart or map and the date of its use. These data are based on observations of the earth's magnetism at numerous places over the country and in adjacent water areas, from which the variation of the compass may be obtained at any desired place.

Increased activities in earthquake investigation, made possible by more funds, should lead to practical results. A plan for obtaining exact information regarding strong earthquakes in their central region is expected to give invaluable data. There is much still to be learned, however, before it can be possible to make use of what will eventually be known about earthquakes, so that it can be possible, for instance, to design structures that will not necessarily be destroyed by them.

As long as the waters move, earthquakes occur, and engineers alter channels, changes will take place requiring resurveys and amendments to records to show these ever-changing conditions in the interests of human safety.

Provision of aids to air navigation for maintaining safety in air travel along the routes of the Federal airways system is a responsibility of the Aeronautics Branch. At the end of the fiscal year 1931 there were 17,500 miles of airways lighted and under construction, which are or will be equipped with radio direction, communication facilities, and weather-reporting services. In addition there are 1,123 miles of airways which have been or are being provided with certain air-navigation facilities for day operations and which will be completed for night operations in the future. It is contemplated that the Federal airways system eventually will include 25,000 miles of trunk-line airways.

Rotating beacon lights are installed on the airways at 10-mile intervals, and lighted intermediate landing fields are provided at 40 to 50 mile spacings. Radio range beacons give directional guidance at all times, and are especially valuable when low visibility makes it difficult or impossible for pilots to see the beacon lights. Radio-broadcasting stations provide current information as to weather conditions to aircraft in flight at half hourly intervals. This information is collected from weather stations by means of automatic telegraph-typewriter circuits, and the stations of these circuits, situated on the airways, also report the movements of planes when requested.

At the end of the fiscal year there were 350 intermediate landing fields, 1,725 airways beacons, 178 airways weather-reporting stations,

48 airways radio communication stations, 51 radio range beacons, and 24 radio marker beacons in operation on the Federal airways system.

Also in the interests of safety, the Aeronautics Branch licenses airmen who are competent and aircraft that are airworthy. In addition the branch approves aircraft as types, granting to those which qualify, approved type certificates or group 2 approvals, the former for planes to be produced in quantity and the latter for craft of which limited numbers are to be manufactured. Aircraft engines, and certain accessories also are inspected, tested, and if qualified, approved.

All of the regulations governing civil aeronautics have safety as an essential consideration. These include the air commerce regulations and air-traffic rules; the airworthiness requirements for aircraft; rules governing the approval of flying schools; entry and clearance regulations for aircraft crossing the national boundary; parachute regulations; regulations governing scheduled operation of interstate passenger air transport services; airworthiness requirements for engines and propellers; and regulations governing alterations to licensed aircraft. During the year a draft was prepared of the projected airworthiness requirements for aircraft components and accessories.

The regulations governing scheduled interstate air passenger service, promulgated during the fiscal year 1930, have demonstrated their value, and all of the air lines having services of this type now are operating under letters of authority from the Department of Commerce. These regulations deal with the adequacy and airworthiness of equipment and competency of personnel.

A great part of the research program of the Aeronautics Branch is directed at achieving increased safety in flight. Objects of this research include improved radio aids, refinement of airplane running lights and airway lights, improvement of airplane-control surfaces, and crash-resistant fuel tanks. Many contributions already have been made to aeronautics by the Aeronautics Branch research workers, particularly in the field of radio.

Another activity contributing to safety of flight is compilation of maps for air navigation. These maps, prepared by the airway mapping section of the Aeronautics Branch, which is located at the Coast and Geodetic Survey, are extremely accurate geographically and show prominently the airports, airway facilities, and other features with which airmen are particularly concerned.

The Bureau of Standards contributes to progress in human safety through its research work. It has pioneered in the use of radio for safety purposes. An early contribution was the radio direction finder and radiobeacon system, which is now one of the mainstays of marine navigation. At the present time it is active in applying radio to the needs of safety in air navigation. It has developed, for the Aeronautics Branch of the department, a radio range-beacon system to guide aircraft along the airways. A recent refinement is the development of a system of visual indicators for the range beacons. Service tests of this system on the airways have begun.

One of the outstanding present needs of aviation is a means whereby pilots may make landings when wholly blinded by fog. The Bureau of Standards has developed a system of radio aids for blind landing, which gives the pilot continuously during landing

full information on height, lateral position, and distance. This system has progressed to the point where service tests on the airways are about to begin.

Along streets and highways.—During the past year the National Conference on Street and Highway Safety has continued its work for uniformity in traffic regulation. The uniform vehicle code and the model municipal traffic ordinance, as revised by the Third National Conference in 1930 and approved by the National Conference of Commissioners on Uniform State Laws and the American Bar Association, were widely used as guides in the preparation during 1931 of State motor vehicle laws and municipal traffic ordinances.

The uniform operators' and chauffeurs' license act was adopted this year by Iowa, Kansas, Michigan, Colorado, and Oregon, bringing up to 19 the number of States having the standard drivers' license law with mandatory examination, besides 7 States requiring motor-vehicle operators and chauffeurs to be licensed but without mandatory examination of new drivers.

The uniform act regulating traffic on highways (Act IV of the Uniform Vehicle Code) was enacted this year in four additional States—Colorado, Nebraska, Oregon, and Utah—bringing up to 18 the number of States having adopted that act or revised their laws to accord therewith.

Since Act IV of the uniform code, as revised in 1930, incorporated many of the provisions found formerly only in the model municipal traffic ordinance, a means is thus afforded of establishing through State law enactment, uniformity in a larger part of the traffic rules and regulations of all cities and towns within the borders of a State. Municipalities in States adopting Act IV of the code, therefore, need to deal with but relatively few additional matters by municipal traffic ordinance. The model municipal traffic ordinance provides a national standard covering such matters. The ordinance has been adopted by many cities and towns, both large and small, during the past year.

The manual on street traffic signs, signals, and markings, giving shape, size, color, location, etc., recommended for devices essential to safe and orderly conduct of traffic in cities and towns has been designed for adoption by traffic authorities without need for legislation and is in accord with the provisions of the uniform code and model ordinance. Its standards are in harmony with the system of standard rural signs adopted by the American Association of State Highway Officials and are already in effect in a large number of cities and towns and are rapidly replacing older nonstandard traffic guides.

The organizations participating in the conference have assisted throughout the year in promoting wider adoption of the entire conference program, including uniform traffic regulation, enforcement of traffic laws and regulations, education of highway users, construction and maintenance of motor vehicles, and improvement of street and highway traffic facilities, working directly and through their own local affiliated groups, by State and regional traffic conferences, traffic surveys, radio addresses, and the use of other channels of publicity.

The national conference has assisted in coordinating the efforts of the various cooperating organizations and in making available the collective experience and information.

PROGRESS IN DEVELOPMENT OF CIVIL AERONAUTICS

Progress of a most gratifying character has been made by scheduled air-transport operations during the past fiscal year. Compared with June 30, 1930, the total mileage flown daily by air transport companies both in the United States and on foreign extensions at the end of this fiscal year showed an increase of 37,132. The present total mileage flown on schedule every 24 hours in the United States, and to Canada, the West Indies, and Latin America is 140,314. During the calendar year 1930, 417,505 passengers were carried and nearly 37,000,000 miles were flown.

However, the major portion of the Nation's flying is carried on in miscellaneous operations such as student instruction, aerial sightseeing, exhibition flying, crop dusting, aerial photography, and kindred activities. More than 108,000,000 miles were flown and nearly 3,000,000 persons were carried in this type of activity in the calendar year 1930. Of this number, about 1,850,000 were carried for hire.

The manufacturing phase of the aeronautics industry is rapidly changing from a large number of producing units, many of them small local companies hastily formed to supply a demand for aircraft which seemed apparent a few years ago, to a specialized group surrounded by the highest type of engineering, producing, and marketing personnel obtainable to-day.

Although smaller in number, the manufacturers now producing are better equipped to operate at high capacity than ever before. The factories possess the latest equipment and are operating according to the most efficient production methods, and could doubtless increase their production by a large amount within the next year if the need arose.

The work of the Aeronautics Branch during the fiscal year ended June 30, 1931, has been directed, as in the past, toward the further development of the aircraft industry and the further promotion of civil aeronautics in the United States.

Outstanding in this regard has been the expansion of the Federal airways system which, when completed, will embrace 25,000 miles of airways fully equipped with aids to air navigation for the safe operation of aircraft both day and night.

At present there are 17,500 miles of airways lighted and under construction, which are or will be equipped with radio direction and communication facilities and weather reporting services. Including the 2,000 miles of lighted airways authorized for the ensuing year, the airway program now embraces 19,500 miles.

In addition to the foregoing, there are 1,123 miles of airways which have been or are being provided with certain air navigation

facilities for day operations. Portions of this mileage will be lighted during the ensuing fiscal year and it is possible that some sections will be utilized to bring about minor relocations of airways which experience has indicated will become necessary better to serve the Federal system.

Radio aids to air navigation were increased in number during the year. At present there are 48 airways radio communication stations in operation for the broadcast of weather information to planes in flight at frequent intervals, an increase of 13 over last year, and 10 stations are under construction. Fifty-one radio range beacons are in operation to provide directional guidance by means of radio signals to airmen flying along the airways, an increase of 42 over the previous fiscal year. There are 13 radiobeacons under construction.

At the end of the fiscal year 9,500 miles of automatic telegraph typewriter circuits for the collection and transmission of weather reports along the airways were in operation, an increase of 3,850 miles over the preceding fiscal year.

Of immediate and potential value to aeronautics in general is the research work undertaken by the Aeronautics Branch during the fiscal year just closed. Much of this work is centered on aeronautic radio and at present the problems nearing solution or still under investigation include:

A device for the simultaneous transmission of radiotelephone weather broadcasts and visual type radio range beacon signals on the same frequency;

A system of radio aids to facilitate blind landings of aircraft;

A new improved type visual radiobeacon course indicator;

A simple direction finder for aircraft;

A device known as a deviometer, which permits a pilot to follow any chosen fixed radiobeacon course within 15° on either side.

Other research problems are directed at the reduction of noise from airplane engine exhausts by the use of mufflers; the development of crash-proof tanks; the control of airplanes at low speeds by means of conventional ailerons; a continuation of the study of welded aircraft joints and research into various phases of aeronautical lighting, including airplane running lights, airway beacons, and colors of aviation glasses.

In addition to the foregoing, special research committees of the Aeronautics Branch, organized cooperatively with the industry, are working on problems pertaining to airport traffic control and airport drainage and surfacing. The reports of two other committees, whose work was concluded during the previous fiscal year, were published during the year. One of these committees engaged in a study of the control of hangar fires by the automatic application of water, and the other in a study of airport zoning and eminent domain.

Another indication of the progress in civil aeronautics may be gleaned from the licenses and approvals issued by the Aeronautics Branch following examinations and inspections. A tabulation on this subject follows.

Item	June 30, 1930	June 30, 1931
Licensed airplanes	6,684	7,386
Unlicensed airplanes	3,089	[1] 2,800
Licensed pilots	13,041	16,089
Licensed mechanics	8,843	9,226
Aircraft holding approved type certificates	334	426
Engines with approved type certificates	54	72
Propellers with approved type certificates	174	297
Aircraft with group 2 approvals (approved for license but without A. T. C.)	230	358

[1] The decrease in unlicensed aircraft is regarded as a progressive step toward the elimination eventually of all unlicensed aircraft from operations.

Airports and landing fields also increased in number. At the end of the fiscal year, there were 1,870 such facilities, representing an increase of 215 over the number on record a year before. The present total includes municipal and commercial airports; Army airdromes, naval and Coast Guard air stations; Department of Commerce intermediate landing fields and marked auxiliary fields. There were 541 proposed airports of which the Aeronautics Branch had knowledge at the end of the year.

With the passing of each 12-month period, direct evidence continues to point to the permanent position occupied by aeronautics in our national economic life. Millions of people now are availing themselves of the advantages of air transportation, both scheduled and miscelleaneous in character, and the value of this rapid and direct-route service doubtless has manifested itself to all who have employed it in furtherance of their business and social lives.

CONDENSED REPORTS OF BUREAUS

CHIEF CLERK AND SUPERINTENDENT

DEPARTMENT OF COMMERCE,
OFFICE OF THE CHIEF CLERK,
Washington, July 1, 1931.

The honorable the SECRETARY OF COMMERCE.

DEAR MR. SECRETARY: The year just closed was one of the busiest in the department's history, but notwithstanding the heavy and unusual demands the personnel of the various divisions of the Secretary's Office were equal to the occasion and through willing cooperation enabled us to close the year with all work practically current. Overtime work performed by 70 employees during the year amounted to 589 days.

INTERNATIONAL COLONIAL AND OVERSEAS EXPOSITION

Several of the bureaus of the department are exhibiting at the International Colonial and Overseas Exposition in progress since May at Paris. Due to the fact that the primary object of this exposition is to display the industrial, commercial, and cultural development of colonial possessions, the exhibits of the department are confined almost entirely to a display of graphs, charts, maps, and printed material descriptive of the progress made in trade and industry.

DISBURSING OFFICE

The table following shows the total amount of all appropriations for the various bureaus and services of the department for the fiscal year ended June 30, 1931.

Bureau	Annual appropriation act	Deficiency act	Special act	Total	Allotments by other departments
Office of the Secretary	$725,595.00	$384,445.00	----------	$1,110,040.00	----------
Aeronautics Branch	9,204,830.00	3,200.00	$283.89	9,208,313.89	----------
Radio Division	500,000.00	2,840.00	----------	502,840.00	----------
Federal Employment Stabilization Board	----------	90,000.00	----------	90,000.00	----------
Bureau of Foreign and Domestic Commerce	5,086,660.00	15,000.00	688.00	5,102,348.00	$40,000.00
Bureau of the Census	8,497,000.00	----------	----------	8,497,000.00	----------
Steamboat Inspection Service	1,373,355.00	265.00	----------	1,373,620.00	----------
Bureau of Navigation	459,300.00	1,840.00	2,384.86	463,524.86	----------
Bureau of Standards	2,735,671.00	912,300.00	----------	3,647,971.00	261,243.67
Coast and Geodetic Survey	3,072,104.00	2,920.00	----------	3,075,024.00	41,300.00
Bureau of Lighthouses	13,237,700.00	145,480.00	1,921.50	13,385,101.50	1,025.01
Bureau of Fisheries	2,825,560.00	364,825.00	----------	3,190,385.00	----------
Patent Office	3,773,730.00	36,200.00	----------	3,809,930.00	169,000.00
Bureau of Mines	2,549,480.00	15,580.00	----------	2,565,060.00	----------
Printing and binding:					
All bureaus except Patent Office	645,000.00	10,000.00	----------	655,000.00	----------
Patent Office	1,100,000.00	----------	----------	1,100,000.00	----------
Total	55,785,985.00	1,984,895.00	5,278.25	57,776,158.25	512,568.68

Disbursements during the year ended June 30, 1931, from appropriations and from funds transferred from other departments were as follows:

Bureau	Appropriation for—			Total
	1929 and prior years	1930	1931	
Office of the Secretary	$56.47	$371,016.89	$2,269,753.09	$2,640,826.45
Aeronautics Branch	173,094.48	1,261,675.68	6,752,552.68	8,187,322.84
Radio Division	510.46	26,724.86	496,414.82	523,650.14
Bureau of Foreign and Domestic Commerce	1,623.73	96,363.77	4,872,551.32	4,970,538.82
Bureau of the Census	289.37	466,803.64	19,518,924.59	19,986,017.60
Steamboat Inspection Service	19.70	26,742.04	1,246,064.54	1,272,826.28
Bureau of Navigation	66.76	9,703.31	429,242.49	439,012.56
Bureau of Standards	2,839.17	141,875.30	3,189,822.19	3,334,536.66
Coast and Geodetic Survey	34,849.52	437,354.09	2,650,379.63	3,122,583.24
Bureau of Lighthouses	14,626.80	559,132.61	10,927,593.84	11,501,353.25
Bureau of Fisheries	9,376.07	134,030.92	2,030,025.29	2,173,432.28
Patent Office	7.00	29,601.41	3,726,963.20	3,756,571.61
Bureau of Mines	878.95	149,600.34	4,113,857.58	4,264,336.87
Total	238,238.48	3,710,624.86	62,224,145.26	66,173,008.60

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

Coast and Geodetic Survey: Sale of charts, publications, old property, etc	$76,398.05
Bureau of Fisheries:	
Sale of fur-seal skins	85,772.87
Sale of fox skins	10,330.23
Meals furnished employees at isolated stations	2,921.52
Sale of old property, etc	845.51
Miscellaneous	1.37
Bureau of Standards: Test fees	66,576.15
Steamboat Inspection Service: Sale of old property	31.48
Bureau of Lighthouses:	
Sale of old property	18,944.42
Rent	3,808.00
Government property lost, destroyed, or damaged	11,164.51
Work done	3,867.50
Sale of land and buildings	55.00
Miscellaneous refunds	10,568.51
Bureau of Foreign and Domestic Commerce:	
Registration fees, etc., China trade act	2,075.00
Sale of publications	5,361.97
Sale of old property	170.64
Miscellaneous refunds	48.01
Office of the Secretary:	
Certification fees (37 Stat. 497)	355.75
Sale of strip maps (Aeronautics Branch)	3.15
Penalties for violation air traffic rules	6,380.00
Miscellaneous refunds	290.00
Patent Office: Patent fees	4,470,309.90
Bureau of Mines:	
Analyzing samples	11,557.00
Sale of gas from helium plants	11,497.52
Rental of pipe lines	12,500.00

Bureau of Mines—Continued.	
Sale of property	$5, 159. 51
Miscellaneous refunds	433. 27
Bureau of the Census: Sale of property	1, 030. 40
Bureau of Navigation:	
Tonnage tax	1, 777, 612. 54
Navigation fees	205, 534. 43
Navigation fines	340, 718. 35
Miscellaneous: Refund of gasoline tax	812. 43
Total	7, 143, 134. 99

APPOINTMENT DIVISION

At the close of the year the personnel of the department numbered 23,680 (17,197 permanent and 6,483 temporary). Of the total number 10,488 are employed in the District of Columbia and 13,192 constitute the field force.

The number of employees retired on annuity during the year under the civil service retirement act was 72—54 by reason of age and 18 on account of disability. The average annuity of those retired under the act is $1,023.23. Under the Lighthouse Service retirement system 43 were retired for age with an average annuity of $1,161.43, and 20 on account of disability with an average annuity of $1,147.14. Nine hundred and seventy-six employees have been retired under the two systems to the close of June 30, 1931.

DIVISION OF PUBLICATIONS

The following statement shows for the fiscal years 1930 to 1932, inclusive, the amounts available for printing and binding and the unexpended balances of the appropriations for 1930 and 1931.

	1930	1931	1932
Services other than the Patent Office and the Bureau of the Census: [1]			
Amount available	[2] $649, 300. 00	[3] $655, 000. 00	$750, 000. 00
Expenditures	647, 738. 18	[4] 641, 653. 10	----------
Balance	1, 561. 82	13, 346. 90	----------
Patent Office:			
Amount available	1, 100, 000. 00	1, 100, 000. 00	([5])
Expenditures	1, 096, 331. 11	[4] 1, 067, 964. 62	----------
Balance	3, 668. 89	32, 035. 38	----------

[1] During the decennial census period (July 1, 1929–Dec. 31, 1932) the cost of printing and binding for the Bureau of the Census is paid from appropriations for the Fifteenth Decennial Census.
[2] Includes $34,300 contained in the first deficiency act, fiscal year 1930.
[3] Includes $10,000 contained in the second deficiency act, fiscal year 1931.
[4] Estimated. Exact figures can not be given until all work ordered is completed and billed.
[5] Beginning with the fiscal year 1932 the appropriation for printing and binding for the Patent Office is made to that bureau and not to the Office of the Secretary.

Total receipts from sales of the department's publications for the fiscal year 1930 (the latest period for which complete data are available) were $742,249.88, compared with $677,045.17 for 1929. The

following table presents the details in comparison for the two years by selling agencies and issuing offices.

Sales	Receipts	
	1929	1930
By the Superintendent of Documents: Miscellaneous sales and subscriptions	$231,376.56	$250,831.78
By Coast and Geodetic Survey: Coast pilots, inside route pilots, tide tables, current tables, charts, and airway maps	67,390.91	80,093.75
By Patent Office: Specifications of patents, reissues, etc., trade-mark section and decision leaflet of Official Gazette, and classification bulletins and definitions	378,277.70	411,324.35
Total	677,045.17	742,249.88

DIVISION OF PURCHASES AND SALES

Notwithstanding a large increase in work in the division of purchases and sales, additional personnel was avoided through overtime work and capacity production, which enabled the division to keep pace with the requirements. There were placed during the year 18,927 purchase orders; 700 contracts were examined; the number of requisitions was increased by 853; there was an increase of 216 proposals issued and an increase of 4,761 invitations to bid. The division passed 19,074 vouchers, an increase of 2,769. All leases for the field service, as usual, were forwarded through this division.

Surplus material to the value of approximately $166,903.03 was obtained through the cooperation of the Chief Coordinator from surplus stocks of other Government departments without the transfer of funds.

TRAFFIC OFFICE

The traffic office has functioned efficiently during the year and effected many economies. Cooperation was maintained between the bureaus and the department and with Federal coordinating agencies. Freight shipments were consolidated and land-grant rail routes and Government-operated ships were used wherever possible. Advantage was taken of round-trip or reduced rates for passenger travel whenever opportunity permitted.

DEPARTMENT LIBRARY

Books and pamphlets on commerce, industries, and related subjects in the department library on June 30, 1931, numbered approximately 150,747. Books catalogued during the year numbered 5,747. Progress was made in the bibliographical work, and many useful lists were compiled. A list of periodical publications of foreign and domestic banks was compiled and distributed. An outstanding contribution by the library was the completion of a bibliography giving references to sources of prices contained in periodicals, which is now in the process of printing.

SOLICITOR'S OFFICE

During the fiscal year 652 contracts, 1,285 leases, 12 insurance policies, 23 revocable licenses, 38 deeds, 340 contract bonds, 67 annual bid and performance bonds, and 87 official bonds were examined and approved, disapproved, drafted, redrafted, or modified.

The number of legal opinions rendered, formal and informal, totaled 288; legislative matters handled which concern the Department of Commerce numbered 73; power of attorney cards, authorizing agents to execute official and contract bonds for surety companies, totaled 3,980. In addition 11,820 miscellaneous matters requiring advice or suggestion of the solicitor, or for the formulation of departmental action, not included in the foregoing items, were handled by the solicitor's office.

Very truly yours,

E. W. LIBBEY,
Chief Clerk and Superintendent.

AERONAUTICS BRANCH

DEPARTMENT OF COMMERCE,
OFFICE OF ASSISTANT SECRETARY OF
COMMERCE FOR AERONAUTICS,
Washington, July 1, 1931.

The honorable the SECRETARY OF COMMERCE.

DEAR MR. SECRETARY: In compliance with your request, the following report, on the work accomplished by the Aeronautics Branch in the fiscal year 1930–31 and describing the present state of air commerce in the United States, is respectfully submitted.

ORGANIZATION AND FUNCTIONS

The air commerce act of 1926 charges the Secretary of Commerce with the responsibility of promoting and regulating air commerce. The act created the office of an additional Assistant Secretary of Commerce to administer the details of this work. Shortly after the approval of the act by the President, the Aeronautics Branch was organized. On June 30, 1931, it completed its fifth year of activity.

The Aeronautics Branch is divided into three major parts as follows: The air regulation service, the airways division, and the aeronautic development service. The three officials in charge of these respective units are responsible to the Assistant Secretary, and with the latter as chairman they also constitute the membership of the executive board of the Aeronautics Branch which formulates all policies affecting the present activities and future plans of the branch.

The functions of the three principal agencies of the Aeronautics Branch are set forth in the following pages.

AIR REGULATION SERVICE

The air regulation service carries out the details of the regulatory powers vested in the Secretary of Commerce by the air commerce act. The purpose of the air regulation service is twofold: (1) To insure that all flying operations over which it has jurisdiction are conducted in airworthy aircraft piloted by competent airmen, and in conformity with standard air traffic rules; and (2) to foster the development of air commerce through the safe and reliable operation of such aircraft and airmen. However, the fundamental principle of the air commerce act is to afford the aeronautic industry every possible opportunity to regulate itself, and from the beginning the industry has cooperated with the Federal Government in this regard.

The functions of the air regulation service are assigned to three main divisions and are coordinated under the director of air regulation. These divisions are: Inspection service, licensing division, and engine testing section, the latter organized at the Bureau of Standards.

INSPECTION SERVICE

The inspection service is the field service division of the air-regulations phase of the Aeronautics Branch. It is charged with the following duties:

(*a*) Inspection and testing of aircraft, including gliders, for approved type certificate and group 2 approvals.
(*b*) Inspection of aircraft repair stations for approved repair station certificate.
(*c*) Inspection of civilian flying schools for approved schools certificate.
(*d*) Inspection of interstate passenger air transport lines for certificate of authority to operate.
(*e*) Inspection and testing of parachutes for approved type certificate.
(*f*) Inspection of aircraft for license and renewal of license.
(*g*) Inspection of repairs to damaged aircraft.
(*h*) Inspection of factories building approved type aircraft.
(*i*) Examination and flight testing of pilots for license.
(*j*) Examination and flight testing for flying instructor's rating.
(*k*) Flight testing of pilots for passenger-carrying ratings in various classes and weights of aircraft.
(*l*) Examination of ground instructors for license.
(*m*) Examination of mechanics for license.
(*n*) Examination of parachute riggers for license.
(*o*) Field investigation of accidents in civil aeronautics.
(*p*) Investigation of reported violations of the regulations.
(*q*) Field enforcement of the Air Commerce Regulations and the Air Traffic Rules.

Inspectors employed to carry out the foregoing duties are of two general classes:

1. Pilots of unusual qualifications who, on account of the nature of their work, must have not only expert flying ability and 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. Inspectors in this class who have other special qualifications, such as executive ability or a knowledge of engineering or flight training, are selected to fill the positions of supervisors, aeronautical engineering inspectors, aeronautical school inspectors, and air-line inspectors.

2. Airplane inspectors are selected for their intimate knowledge of structural details in the manufacture of aircraft and need not be pilots. These men are stationed at the aircraft factories and at district headquarters where large numbers of aircraft require inspection for license and relicense. Inspectors in this class who have special qualifications are selected to fill positions as air-line maintenance inspectors, which position has developed during the past year in connection with inspection of interstate passenger air transport lines.

The pilot inspectors are subdivided into five classes, namely, supervising aeronautical inspectors, aeronautical inspectors, air-line inspectors, aeronautical engineering inspectors, and aeronautical school inspectors. At the close of the fiscal year the inspection service had in its employ a total of 88 inspectors, 75 of whom are pilot aeronautical inspectors and 13 factory (airplane) inspectors. This personnel was assigned as follows: Chief, inspection service; assistant chief, inspection service; supervisor, air-line inspection; 9 district supervisors; 8 aeronautical engineering inspectors; 9 aeronautical school inspectors; 6 air-line inspectors; 40 aeronautical inspectors; and 13 airplane inspectors. Of the 13 airplane inspectors, 2 were assigned to air-line maintenance inspection.

The inspection of passenger air transport lines has increased in importance to such an extent that the number of men assigned to this activity was increased at the close of the fiscal year. The present air-line inspection program provides for the assignment of four air-line inspection crews, each crew consisting of two air-line inspectors and one air-line maintenance inspector. These crews will be stationed at New York, Chicago, Dallas, and Los Angeles.

During the year the efficiency of the field engineering inspection work was materially improved by the establishment of four engineering bases for the flight testing of new types of aircraft for approval. Two engineering inspectors are stationed at each of these bases which are located at New York, Detroit, Kansas City, and Los Angeles. The stations are equipped with adequate facilities, including scales and instruments for the flight testing and weighing of new types of aircraft. The establishment of additional engineering bases would facilitate the handling of the engineering test work since engineering inspectors are still required to travel to some of the factories which are not located within a convenient distance of the present bases.

Revisions were found necessary in the regulations governing alterations and repairs to licensed aircraft and the approval of repair stations. These revisions have resulted in the establishment of a larger number of competent service depots and repair stations.

Parachute regulations, which became effective just before the beginning of the last fiscal year, have brought quite satisfactory results in that all the standard makes of parachutes have been thoroughly inspected and tested for approved type certificate. Also, under these regulations parachute riggers have been examined and licensed for the packing and servicing of commercial parachutes in the field.

Whereas during the past year there has not been any marked peak in the work handled by the inspection service, the field activities have shown a steady increase due to the volume of work necessary in connection with the increase in renewals of existing aircraft and airmen licenses as well as in the issuance of additional original licenses. The work of the inspection service is still handicapped by the lack of sufficient aircraft for the use of inspectors. This need is measurably cared for in the 1932 fiscal program, which permits the placing of one additional airplane in each of the nine inspection districts.

The inspection service is current with its work, regarding the handling of all types of applications with the possible exception of the passenger air transport lines. The majority of these have been given a preliminary inspection, the results of which warrant the authorization for their continued operation pending the issuance of the actual certificate after final inspection has been completed.

LICENSING DIVISION

The licensing division is responsible for the preparation and issuance of all aircraft and airmen licenses and their renewals; for the transfer of title to aircraft assigned Department of Commerce numbers; for the issuance of certificates of airworthiness for export for aircraft sent to foreign countries having reciprocal agreements with the United States; for the validation of certificates and the maintenance of all files and records pertaining to the foregoing; for deter-

mining whether aircraft for which approvals are asked are of proper structural design; for examining pilots and student pilots as to their physical and mental fitness for flying before they are licensed and checking by periodic physical examination those who are already licensed; for handling the technical 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, and for the assessment of penalties; for acting in a general advisory capacity in all matters pertaining to air law; and for determining the causes of all civil aircraft accidents.

This division is divided into five sections, as follows: Medical section, registration section, enforcement section, accident board, and engineering section.

MEDICAL SECTION

The number of medical examinations handled by the medical section during the fiscal year was 39,386, or 10.2 per cent less than during the previous fiscal year. It will be noted, however, that the difference is largely due to the reduction in the number of students trained during the last fiscal year. Comparative figures for the past three fiscal years follow.

TABLE 1.—*Medical examinations*

	Fiscal year—		
	1928–29	1929–30	1930–31
Original examinations, trained pilots	3,709	2,701	894
Reexaminations, all classes	8,013	18,595	23,296
Student pilots, original examinations	16,756	22,606	15,196
Total	28,478	43,902	39,386

While student examinations have fallen off 32.7 per cent during the last fiscal year, as compared with the fiscal year 1929–30, the number of renewal examinations have increased 25 per cent in the same period. In the table it will be noted that during the last fiscal year only 894 original examinations of trained pilots have been received as compared with 2,701 during 1929–30 and 3,709 during 1928–29. The yearly figures under this heading are important as they indicate the rapid reduction in the number of applicants receiving unlicensed training. As practically all applicants are now receiving their training as licensed students, their original examinations appear under the heading "Student pilots, original examinations." As unlicensed flying training becomes still less, the numbers appearing under the heading "Original examinations, trained pilots" will become still fewer.

The pronounced reduction in student applications began in November, 1930, and while student training revived considerably during the last quarter, the showing for the fiscal year is considerably less than during the fiscal year 1929–30.

The medical field force has remained practically unchanged as far as numbers of examiners are concerned. In many localities the need for medical examining units has ceased to exist while activity in new localities has led to the establishment of additional medical units.

The shifting of the examining service in response to the changing needs of the industry has led to a more satisfactory medical arrangement without making the field medical organization unduly large. Numerous group meetings with the medical examiners in various localities by the medical director and assistant medical director have resulted in a material improvement in the efficiency of the field organization. In June, 1930, there were 816 authorized medical examiners. At this time there are 798.

The medical section devoted the past several months of the fiscal year to a detailed study of the effect of physical deficiencies on the performance of students and pilots. This analysis will be ready for presentation shortly. It already shows that physical deficiencies have a very deterrent effect on the ability of students to obtain a pilot's license, and that licensed pilots with physical defects have higher nonfatal and fatal accident rates than those who are physically normal.

These studies have been made in order to determine to what extent, if any, the physical requirements might be altered in favor of the applicant. The study shows that the physical requirements are exceptionally lenient and that, based on the performance of applicants barely meeting them, further relaxation of the requirements is not desirable at this time.

REGISTRATION SECTION

The registration section is composed of five units: Administrative, aircraft, airmen, sales, and files, performing the following main functions:

1. Review of all applications for licenses submitted for aircraft and airmen for compliance with the Air Commerce Regulations.
2. The technical review of aircraft inspection reports for conformity with approved type certificates.
3. The preparation and issuance of all licenses for aircraft and airmen.
4. Recording of ownership and transfer of title to aircraft.
5. Maintenance of all files and records pertaining to aircraft and airmen.
6. Preparation of correspondence relating to status of aircraft and airmen's licenses.
7. Preparation of forms for applications and licenses pertaining to aircraft and airmen in conformity with the Air Commerce Regulations.

The section acts as a liaison group for the licensing division in that it coordinates information with respect to the issuance of licenses for aircraft and airmen.

During the fiscal year 44,206 licenses, renewals of licenses, transfers of title, and export certificates were acted upon. The total volume of work during the year amounted to 110,657 accountable items, consisting of original and renewal applications received, sales recorded, and licenses and other certificates issued, which is a decrease of 4 per cent from that of the previous year.

The total number of applications for aircraft and airmen licenses during the fiscal year and the present status of active licenses are shown in the following tables:

TABLE 2.—*Total applications received and certificates issued for fiscal year ended June 30, 1931*

Item	Number	Percentage of increase or decrease as compared with previous fiscal year	Item	Number	Percentage of increase or decrease as compared with previous fiscal year
Aircraft:			Mechanics:		
Applications received	11,367	+4	Applications received	2,515	−49
Certificates issued	10,860	+8	Certificates issued	1,666	−55
Certificates renewed	3,985	+75	Certificates renewed	1,861	−16
Transfer of title on new and used aircraft	7,578	+10	Total	6,042	−44
Total	33,790	+12	Grand total	110,657	−4
Airmen:					
Applications received	28,483	−15			
Certificates issued	26,528	−16			
Certificates renewed	15,814	+69			
Total	70,825	−5			

NOTE.—Certificates include all classes of licenses, as well as identification-mark assignments and export certificates.

TABLE 3.—*Status of active licenses for fiscal year ended June 30, 1931*

Item	Number	Percentage of increase or decrease as compared with previous fiscal year	Item	Number	Percentage of increase or decrease as compared with previous fiscal year
Aircraft:			Airmen:		
Licensed	7,458	+12	Pilots	16,268	+25
Identified	2,777	−10	Students	14,244	+67
Gliders:			Glider pilots	238	+510
Licensed	100	----------	Glider students	974	----------
Identified	1,107	+48	Mechanics	9,222	+4
Export certificates:			Parachute riggers	171	----------
Aircraft	394	+30	Ground instructors	153	−34
Engines	26	----------			

ENFORCEMENT SECTION

The enforcement section handles the technical 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 were 6 public hearings held, 7 cases were referred to the Department of Justice, and $5,005 in assessed penalties was collected. Other details of these enforcement activities appear in the following table:

TABLE 4.—*Analysis of enforcement of Air Commerce Regulations, fiscal year ended June 30, 1931*

Nature of violation	Total	Number assessed	Repri-mands	Suspen-sions	Revoca-tions	Denials	Dismis-sals
Acrobatics	224	73	21	86	11	----------	15
Low flying	212	43	29	45	4	1	85
Unlicensed pilot flying licensed plane	102	48	25	10	1	5	13
No navigation lights	17	----------	2	8	2	----------	5
No identification numbers	13	3	4	6	----------	----------	----------
Miscellaneous offenses	600	101	92	159	45	12	188
Total	1,168	268	173	314	63	18	306

A number of special matters were handled during the past year by the section, including a complete revision of the Air Commerce Regulations, which now consist of a main publication on general regulation, supported by 10 supplementary codes on special phases of aeronautical work.

During the year several cases having a far-reaching effect upon the future development of aviation came to trial, and in two, namely, the case of Swetland *v.* Curtiss Airports Corporation et al. and Hagymasi *v.* Colonial Western Airways (Inc.), a representative of the section acted in an advisory capacity in each case to the presiding judge.

Coordination work between the department and the various State aeronautical regulatory bodies materially increased during the year, and a number of conferences with State officials were attended.

ACCIDENT BOARD

The purpose of the accident board is to analyze and determine the causes of all civil aircraft accidents; to initiate action for suspension or revocation of aircraft licenses according to the extent of the damage incurred; to disseminate pertinent accident information to the various sections of the Aeronautics Branch; and to prepare basic facts for statistical compilation and analysis.

The board consists of two pilots, a flight surgeon, an aeronautical engineer, a lawyer versed in air law, and a statistician, thus providing a background of expert knowledge to the analysis of all aircraft accidents.

For statistical purposes, aircraft accidents are divided into three groups, as follows:

(1) *Accident.*—This group includes all accidents to aircraft operating as such which involve death or serious injury to persons and wherein damage incurred by the aircraft is sufficient to necessitate an inspection of repairs by an authorized Department of Commerce inspector before being reflown.

(2) *Mishap.*—This group includes all accidents to aircraft operating as such which do not involve death or serious injury to persons and wherein damage incurred by the aircraft is not sufficient to necessitate an inspecton by an authorized Department of Commerce inspector before being reflown.

(3) *No accident.*—This group includes all accidents occurring to aircraft while not being operated as such, such as hangar fires, windstorms, floods, etc.

NOTE.—For purposes of the foregoing grouping, an aircraft is considered to be "operating as such" from the time of take-off until the landing has been completed.

All aircraft accidents, regardless of statistical grouping, are analyzed as nearly as is practical in accordance with the method outlined by the special committee on aircraft accident analysis, and published by the National Advisory Committee for Aeronautics in their Report No. 357. This method was developed by the special committee as a basis for analysis, classification, and comparison of aircraft accidents, which would conform to a standard and be universally comparable for both civil and military accidents. Slight deviations from this method are necessary inasmuch as the Aeronautics Branch is concerned with accidents to civil aircraft only, and most of the accident information sought from the department varies widely from information relating to military accidents.

All accidents involving fatal or serious injury are immediately investigated by a Department of Commerce inspector. Other accidents are covered from the Washington office through correspondence. Forms are mailed to the persons involved and are completed by the pilot, operator, or owner and returned to the accident board. The board has made a successful effort to secure reports on all aircraft damaged through accidents, however slight. As a result, records are inclusive enough to develop accurate statistics on the part accidents have played in aircraft operation.

Accident forms and office procedure remain essentially the same as last fiscal year, and have proved very successful. The preliminary report form developed during the previous fiscal year has been of much assistance during the fiscal year of 1931. In event of an aircraft accident in his territory, whether minor or serious, the inspector immediately completes this form in duplicate and forwards one copy to the Washington office. This form contains sufficient information for the Washington office not only to contact the proper parties for a complete report but to suspend or revoke the aircraft license immediately where damage incurred by the aircraft is sufficient to render its operation unsafe. The copy of this form retained by the inspector contains sufficient information to insure that every part of the aircraft damaged will be covered by inspection after repairs have been made.

Through the analysis and study of aircraft accidents, the Aeronautics Branch has been able quickly to locate and remedy structural weaknesses in various types of aircraft and to restrict pilots who have demonstrated their inability to fly aircraft properly and safely. The work has proved a reliable indication of the progress of aviation and has pointed the way to making the Air Commerce Regulations more effective.

ENGINEERING SECTION

During the past fiscal year the engineering section has handled several special projects and dealt with an ever-increasing amount of technical data without making substantial additions to personnel.

Consistent with the policy of expediting action as much as possible in connection with the examination of manufacturers' and owners' technical data, a western office engineering section was created during the year by transferring two aeronautical engineers to Los Angeles, Calif. This plan makes it possible for manufacturers and owners

west of the Rocky Mountains to make as favorable personal contacts as can be made by eastern and midwestern concerns with the main office in Washington.

The preparation and publication of the following new bulletins to supplement Aeronautics Bulletins Nos. 7 and 7–A represent an important step toward familiarizing the public with the requirements of the Aeronautics Branch:

Aeronautics Bulletin No. 7–D, Parachute Supplement of Air Commerce Regulations.

Aeronautics Bulletin No. 7–F, Airworthiness Requirements of Air Commerce Regulations for Airplane Components and Accessories. (In preparation.)

Aeronautics Bulletin No. 7–G, Airworthiness Requirements of Air Commerce Regulations for Engines and Propellers.

Aeronautics Bulletin No. 7–H, Air Commerce Regulations Governing Aircraft Repairs and Repair Stations.

One of the most interesting accomplishments of the year was in connection with the development of the autogiro for commercial use.

Following a conference with the inventor of the autogiro, tentative autogiro airworthiness requirements were drawn up and applied in the examination of three complete designs. Two of these have been approved, one being granted an approved type certificate and one being placed on Group 2 status. The examination of the third design is being completed at this time. A conference is to be held in the near future to correlate the experience and knowledge of all those concerned with the autogiro in order to produce specific standards and requirements relative to complete Department of Commerce approval of such aircraft.

Aeronautics Bulletin No. 7–A, Airworthiness Requirements of Air Commerce Regulations, along with the supplementary bulletins previously mentioned, is subject to certain revisions and additions each year. It is the responsibility of the engineering section to observe and study during the year the suitability of the existing requirements. Following a study of pertinent Army and Navy airworthiness factors and conferences with the aircraft manufacturers, this bulletin was revised and reissued. The conferences each year with the manufacturers of aircraft are an invaluable aid in drafting requirements which are consistent with the production of airworthy aircraft and at the same time do not impose upon a designer's initiative.

During the past fiscal year 98 approved type certificates were granted for airplanes, 19 for engines, 39 for parachutes, and 235 for propellors. In addition, 132 types of airplanes, 1 glider, and 17 propellers were examined and approved for license without being granted approved type certificates. There were also numerous approvals of such components as pontoons, skis, flares, wheels, tail-wheel shock absorbers, shock-absorbing struts, navigation lights, and autogiro rotor hubs.

A total of 4,569 technical subjects were considered during the year as compared with 3,465 during the previous year.

Figure 2 shows the variations in the number of technical entries over a 3-year period. Figure 3 shows the plot of incoming work for each month of the past fiscal year.

ENGINE TESTING SECTION

The testing of commercial engine types by the Aeronautics Branch to determine their suitability for use in licensed aircraft is the function

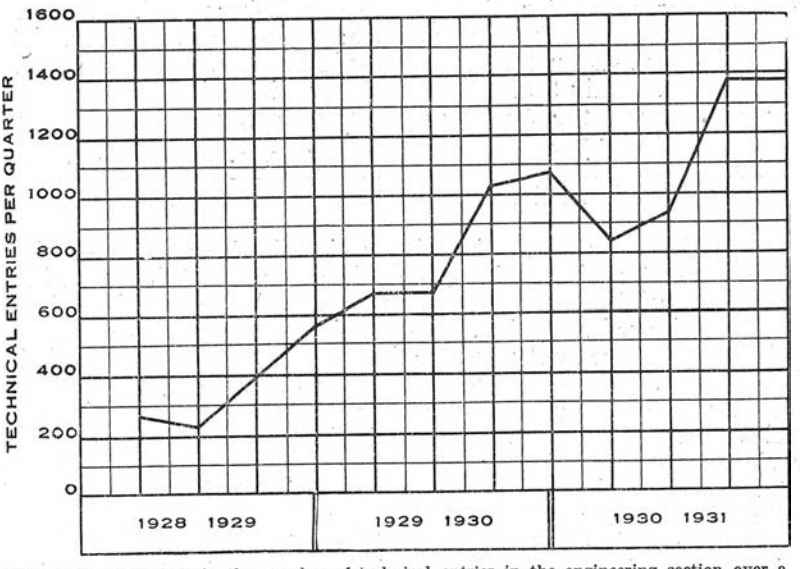


FIGURE 2.—Variations in the number of technical entries in the engineering section over a 3-year period

of the Arlington engine-testing laboratory organized under the Bureau of Standards, to which the Aeronautics Branch transfers the necessary funds for conducting such tests. With three torque-stand testing

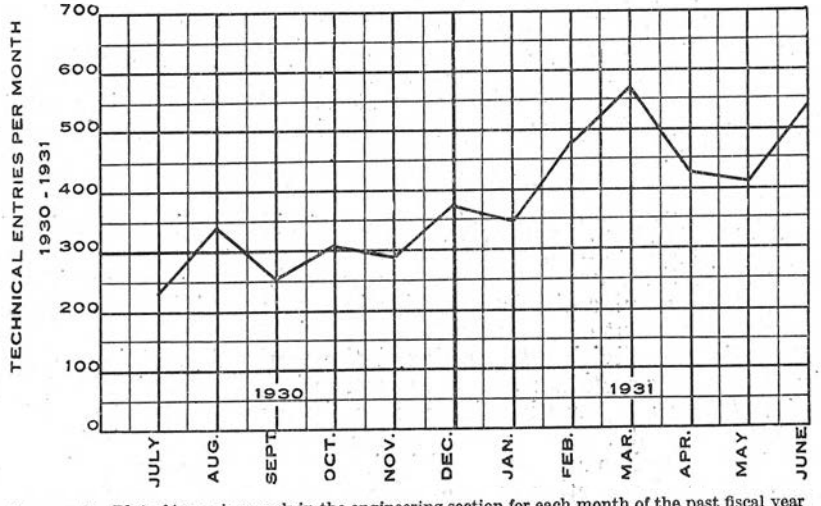


FIGURE 3.—Plot of incoming work in the engineering section for each month of the past fiscal year

units continuously available and a fourth unit in reserve, it has been possible in most instances to schedule the official test at the convenience of the manufacturer as soon as he has met the preliminary test requirements.

During the year tests were undertaken on 27 engines, and of this number 14 passed, 10 failed, 2 were withdrawn, and 1 is still under test. Seven of the engines which failed were new types and three had received one previous test each. Crank-case breakage was the most common source of major failure, three cases being noted. The following parts each caused one major failure: Crank shaft, cylinder, piston, connecting rod, exhaust valve, crank-pin bearing, and counterweight retainer bolt. Only 3 of the 10 engines which failed ran more than halfway through the 50-hour endurance test, and 5 were wrecked before completing the first 5-hour period. Although the percentage of failures has continued to decrease, the results indicate that in many instances there is need for more development work on the part of manufacturers.

The engines showed considerable variety both as to type and size. There were 11 radial engines, including 1 Diesel, 8 inverted in-line engines, 4 horizontal-opposed engines, and 4 V-type engines, including a 12-cylinder inverted V. Five engines tested had less than 200 cubic inch displacement and 3 engines had more than 700 cubic inch displacement. While the total number of engines submitted was much less than in the previous year, the fact that 9 engines were received during the fourth quarter indicates an early return to the previous rate of 1 engine a week.

An aircraft engine is approved for use with fuels equal or superior to that used during the official test. In view of the recent adoption by the automotive and petroleum industries of octane numbers to designate the detonation characteristics of gasolines, the minimum fuel requirements of all approved engines have been expressed in terms of approximate octane numbers. The values for different engines range from 55 to 85 octane number.

The Army Air Corps in selecting commercial engines for use in training planes has considered only those approved by the Department of Commerce and subjected each engine to a 100-hour test, more than 50 hours of which was at full throttle. This example and the action of one manufacturer in requesting that his engine be run at full throttle throughout the endurance test suggest that some increase in the severity and scope of the present official test should receive early consideration.

AIRWAYS DIVISION

The establishment and maintenance of aids to air navigation is carried on by the airways division of the Aeronautics Branch organized within the Bureau of Lighthouses, and, so far as practicable, through the regular district organizations of the Lighthouse Service of the Department of Commerce.

The airways division has assigned the work of establishment of airways to four sections: Survey, construction, communications, and radio. The survey section 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 section 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 communications section selects, establishes, and supervises the operations of airways weather-reporting stations and airways communications stations. The radio section designs, procures, and supervises the erection

and installation of radio equipment for communications stations and radiobeacons.

Maintenance of air navigation aids is accomplished mainly by the lighthouse districts to which have been added the necessary special personnel. Two maintenance organizations, in addition to the regular lighthouse districts, have been required. These units, in charge of airways engineers, are concerned solely with the maintenance of aeronautical aids and are located at Salt Lake City, Utah, and Fort Worth, Tex. To them is assigned the territory between the Mississippi Valley and the Pacific Coast States. At the close of the fiscal year there were 31 airways engineers, 121 airways mechanicians, and 1,139 airways keepers, attendants, and caretakers employed in the maintenance of the airways. There were 2,100 persons in the employ of the airways division on June 30, 1931, of whom 808 were part-time caretakers.

The divisions of finance, law and property, and personnel, of the Bureau of Lighthouses, function in their respective capacities for the airways division, thus obviating the necessity for special units to handle these matters.

AIR NAVIGATION FACILITIES ON FEDERAL AIRWAYS

The construction program of the fiscal year 1931 comprised the establishment of lights, the installation of day fields, the establishment of radiocommunication stations, radiobeacons, radiomarker beacons, and the addition of automatic telegraph-typewriter circuits for communications and weather reporting on the airways.

Contracts were let for lighting the following airways: Jacksonville-Richmond, San Diego-El Paso, El Paso-Fort Worth, Dallas-Louisville (Nashville-Louisville section), Dallas-Atlanta (Meridian-Birmingham section), San Diego-Los Angeles, Los Angeles-Amarillo (Daggett-Amarillo section), Amarillo-Kansas City (Amarillo-Waynoka section), and New Orleans-Atlanta. Day fields were established on the Dallas-Meridian section of the Dallas-Atlanta airway and on the Dallas-Nashville section of the Dallas-Louisville airway.

Because of changes in the routing and scheduling of air-mail contract and passenger-carrying lines the improvement of existing airways was undertaken in order to provide more direct courses and larger intermediate fields suitable for the larger types of aircraft coming into general use as a result of combined mail, express, and passenger cargoes. Such work was undertaken on the Washington-New York, Chicago-New York, San Francisco-Salt Lake City, Fort Worth-Kansas City, Kansas City-Chicago, and Louisville-Cleveland routes.

At the close of the fiscal year there were 17,500 miles of airways lighted and under construction and 1,123 miles under construction for day operation.

During the fiscal year the United States Weather Bureau established 112 special airways weather-reporting stations in addition to the 230 already in operation. These stations furnish frequent reports of local conditions, which are transmitted by the communications network of the airway to the airport stations along the airway and to other stations in the vicinity.

Additional automatic telegraph-typewriter circuits have been established by the Aeronautics Branch for weather-reporting service,

comprising a system of 9,500 miles in length with 178 stations. During the fiscal year 3,846 miles of circuits were established. The circuits now in operation are:

San Diego to San Francisco.
San Francisco to Portland.
Seattle to Pasco via Portland.
San Francisco to Salt Lake City.
Salt Lake City to Cheyenne.
Cheyenne to Omaha.
Los Angeles to Albuquerque.
Albuquerque to Kansas City.
Kansas City to Chicago via Omaha.
Kansas City to Indianapolis via St. Louis, Evansville, and Columbus.
Cleveland to New York.
Cleveland to New York via Columbus, Pittsburgh, Bellefonte, and Philadelphia.
St. Louis to Cleveland via Chicago and Detroit.
McConnellsburg, Pa., to Boston via Washington and New York.
Atlanta to Washington.
Atlanta to Chicago via Chattanooga, Nashville, Evansville, and Terre Haute.
Fort Worth to Dallas.
Pocatello, Idaho, to Idaho Falls.

The volume of weather reports which must be received, correlated, and transmitted daily has made it necessary to establish zones with a principal or headquarters United States Weather Bureau office to supervise the aeronautical weather service in the zone and act as a clearing house for weather information. Such principal weather stations are located at Cleveland, Omaha, Salt Lake City, Oakland, Portland (Oreg.), Atlanta, and Dallas.

Likewise the volume of radio and automatic telegraph-typewriter traffic on the airways communication system requires closer supervision and direction than can be given by the airways traffic supervisor at Washington. Accordingly, the communications system has been divided administratively into 11 districts each under operating direction of an assistant airway traffic supervisor. Assistant airway traffic supervisors are at present stationed at the airways communication stations at Newark, N. J.; Cleveland, Ohio; Atlanta, Ga.; Chicago, Ill.; St. Louis, Mo.; Cheyenne, Wyo.; Salt Lake City, Utah; Los Angeles, Calif.; Portland, Oreg.; Albuquerque, N. Mex.; and Fort Worth, Tex. Supervisors are located at Los Angeles and Cheyenne in lieu of those formerly at Oakland and Omaha, and the supervisors at Chicago, Portland (Oreg.), Albuquerque, and Fort Worth are in charge of new communications districts organized during the fiscal year 1930. At the close of the fiscal year 444 licensed radio operators were on duty at the airways communication and radiobeacon stations, an increase of 206 during the year.

RADIO FACILITIES

The radio communications stations operated by the airways division are 2-kilowatt radio telephone and telegraph transmitters with associate equipment. These transmitters operate on frequencies between 190 and 500 kilocycles and are used for communications by voice with aircraft and for point-to-point communications using frequencies from 2,500 to 12,210 kilocycles. High-frequency and low-frequency receiving equipment is also installed and the station is capable of receiving on any frequency from 75 to 13,000 kilocycles. Where required, an emergency power supply has been installed in order to operate all, or a portion of equipment in case of electric power failure. These sets vary in size from 2¼ to 25 kilovolt-amperes.

At the beginning of the fiscal year 37 radio broadcasting stations were in operation at the following locations:

Los Angeles, Calif.
Oakland, Calif.
Portland, Oreg.
Reno, Nev.
Salt Lake City, Utah.
Cheyenne, Wyo.
Omaha, Nebr.
Chicago, Ill.
Cleveland, Ohio.
Hadley Field, New Brunswick, N. J.
Pasco, Wash.
Wichita, Kans.
Tulsa, Okla.
St. Louis, Mo.
Spartanburg, S. C.
Richmond, Va.
Buffalo, N. Y.
Boston, Mass.
Murfreesboro, Tenn.
Fresno, Calif.
Medford, Oreg.
Seattle, Wash.
Elko, Nev.
Rock Springs, Wyo.
North Platte, Nebr.
Iowa City, Iowa.
Bryan, Ohio.
Bellefonte, Pa.
Boise, Idaho.
LaCrosse, Wis.
Forth Worth, Tex.
Kansas City, Mo.
Atlanta, Ga.
Greensboro, N. C.
Washington, D. C.
Albany, N. Y.
Key West, Fla.

During the fiscal year nine additional stations were erected and placed in operation at the following locations:

Amarillo, Tex.
Butte, Mont.
Idaho Falls, Idaho.
Memphis, Tenn.
Nashville, Tenn.
Birmingham, Ala.
Cincinnati, Ohio.
Jackson, Mich.
Pittsburgh, Pa.

Low-power broadcasting stations were also in operation at Strevell, Idaho, and Pleasant Valley, Nev. Four radio broadcasting stations installed by the Transcontinental Air Transport Co. at Albuquerque, N. Mex., Winslow, Ariz., Kingman, Ariz., and Waynoka, Ariz., were taken over by the department, improved to the adopted standards, and placed in operation.

During the fiscal year the radio stations at Bryan, Ohio, and Murfreesboro, Tenn. (listed in the foregoing), were discontinued and were replaced by the new stations installed at Jackson, Mich., and Nashville, Tenn. (also listed above). The total number of standard broadcasting stations in operation at the end of the fiscal year, therefore, was 48.

In addition to the communications stations regularly broadcasting weather information, three other Aeronautics Branch communications stations were in operation for special purposes. These included a radiotelegraph station at Oklahoma City, employed only for point-to-point telegraph work, and two low-power broadcasting stations located at Strevell, Idaho, and Pleasant Valley, Nev. Also, there were three low-frequency radio transmitters installed by Transcontinental Air Transport at Clovis, N. Mex., Columbus, Ohio, and Indianapolis, Ind., which had been turned over to the Aeronautics Branch.

Radio broadcasting stations were under construction at the close of the fiscal year at:

Big Spring, Tex.
Jacksonville, Fla.
Little Rock, Ark.
Shreveport, La.
Yuma, Ariz.
Charleston, S. C.
Fargo, N. Dak.
Jackson, Miss.
New Orleans, La.
Tucson, Ariz.

These stations were practically completed.

At the beginning of the fiscal year there were nine aural-type radio range beacons in operation at:

New Brunswick, N. J.
Cleveland, Ohio.
Sterling, Ill.
Key West, Fla.
Chicago, Ill.
Bellefonte, Pa.
Goshen, Ind.
Des Moines, Iowa.
Boston, Mass.

During the fiscal year 43 aural-type radio ranges were placed in operation at the following locations:

Albany, N. Y.
Auburn, Calif.
Boise, Idaho.
Burley, Idaho.
Cheyenne, Wyo.
Columbia, Mo.
Elko, Nev.
Atlanta, Ga.
Buffalo, N. Y.
Chattanooga, Tenn.
Cincinnati, Ohio.
Columbus, Ohio.
Erie, Pa.
Evansville, Ind.
Fontana, Calif.
Fort Worth, Tex.
Indianapolis, Ind.
Knight, Wyo.
Moran, Kans.
North Platte, Nebr.
Omaha, Nebr.
Richmond, Va.
Salt Lake City, Utah.
Sidney, Nebr.
St. Louis, Mo.
Syracuse, N. Y.
Tulsa, Okla.
Wichita, Kans.
Fernley, Nev.
Fort Madison, Iowa.
Greensboro, N. C.
Kansas City, Mo.
Medicine Bow, Wyo.
Nashville, Tenn.
Oakland, Calif.
Pasco, Wash.
Rock Springs, Wyo.
Saugus, Calif.
Spartanburg, S. C.
Summit, Calif.
Terre Haute, Ind.
Washington, D. C.
York, Nebr.

Two of the aural ranges listed above were discontinued, those at Auburn, Calif., and Sidney, Nebr., and the visual-type beacon at Detroit was dismantled and is being moved to Fontana, Calif., for use on the Los Angeles-Amarillo airway, making the total number of radio range stations in operation at the close of the fiscal year 51.

Two visual-type radio ranges were in operation during the year at Bellefonte, Pa., and Detroit, Mich.

At the close of the fiscal year 13 radio ranges were under construction at the following locations:

Harrisburg, Pa.
Seattle, Wash.
Medford, Oreg.
The Dalles, Oreg.
Amarillo, Tex.
Winslow, Ariz.
Daggett, Calif.
Pittsburgh, Pa.
Portland, Oreg.
Willows, Calif.
Shasta City, Calif.
Albuquerque, N. Mex.
Kingman, Ariz.

Of this group all were of the aural type except those at Amarillo, Winslow, Daggett, Albuquerque, and Kingman, which were of the visual type. The visual system is being installed along the airway from Los Angeles to Kansas City.

The various radio range stations were in operation well over 98 per cent of the time during the fiscal year, the only off periods being caused by power failures, failures of some part of the equipment, or shutting down for cleaning and adjusting of the equipment.

Twenty-four radio marker beacons consisting of 7½-watt single and double frequency automatic transmitters have been installed at the following locations:

Adair, Pa.
Anderson, S. C.
Atwater, Calif.
Concord, Calif.
Granger, Wyo.
Crewe, Va.
Helmer, Ind.
Laramie, Wyo.
McCool, Ind.
Parkman, Ohio.
Tarkio, Mo.
Winklebleck, Pa.
Allentown, Pa.
Big Spring, Tex.
Blue Canyon, Colo.
Cherokee, Wyo.
Greenville, Ky.
Grinnell, Iowa.
Jefferson, Ga.
Lexington, Nebr.
Monteagle, Tenn.
Pine Bluff, Wyo.
Vincennes, Ind.
Wolcott, Ind.

During the fiscal year the marker beacons at Iowa City, Iowa; Toledo, Ohio; Aurora, Ill.; Lansing, Mich.; and Cicero, Ill., were discontinued.

All of the marker-beacon equipment now in operation has been fitted for radiotelephone transmission as well as for marker-beacon operation. This type of equipment marks a general area about 5

miles in radius by means of radio code signals and indicates to the pilot his approximate location. When within approximately 10 miles of the marker-beacon station the pilot of a radio-equipped aircraft may talk with the operator of the station by voice in order to obtain weather or other information.

Experience in the operation of the marker-beacon system indicates that the installations should be of the directive or radio-range type instead of the nondirective type in order to render field localizing service. This would make it possible for an airman in unfavorable weather conditions to locate the field at which the marker-beacon equipment had been installed and make an emergency landing if necessary. This type of service will require more powerful equipment and with such equipment it will be possible to communicate with aircraft by voice over a distance of 30 to 40 miles. The marker-beacon code signals will be heard over approximately the same distance. Installation of such stations at all the important 50-mile intermediate landing fields is being considered.

Two of the airways division airplanes have been fitted out with radio receiving and transmitting equipment to permit observation of the performance of the airways radio facilities. These ships have done considerable flying during the past year and have proved valuable in improving the quality of radio service.

The airways radio facilities now operate on frequencies from 237 to 285 kilocycles and from 315 to 350 kilocycles. This provides 14 channels for 51 radiotelephone stations and 53 radio range stations. It has been found quite difficult during the past year to operate this equipment on the limited number of channels available without serious interference. It is believed that, for the completed system of airways radio facilities, six additional channels will be required which would extend the lower limit of this band from 237 to 200 kilocycles. In order to conserve frequencies, a system of operating airways radio facilities on a time-sharing basis has been developed using accurate clocks for turning on and off the radio equipment at the proper times. This system consists of operating one radio station during certain minutes of the hour and adjacent radio stations during the remaining minutes of the hour. Although some relief is secured from interference by the use of this system, it has not found full favor with the pilots and its future possibilities are as yet not fully determined.

Two-way communication with aircraft has been in operation along the Salt Lake-Portland and Salt Lake-Great Falls airways during a portion of the past year. The Department of Commerce stations at Salt Lake, Boise, Pasco, Portland, Idaho Falls, and Butte were used to handle the communications from the ground.

An experimental radio automatic telegraph-typewriter circuit has been set up between Bellefonte, Pa., and Buffalo, N. Y., in order to test the feasibility of extension of automatic telegraph-typewriter transmissions from wire circuits to remote points by radio. This circuit has been operated on a frequency in the neighborhood of 200 kilocycles and the operation of the machine has been quite satisfactory except during poor radio conditions. Some consideration is being given to extending this system.

Considerable improvement has been made in the performance of airways radio equipment, particularly in connection with reducing of

harmonic radiations from the transmitters and keeping abreast of new developments in the radio art. Harmonics have been reduced to a point where they cause very little interference with other services, and very few complaints have been received in this respect. A test car has been fitted out for measuring the harmonic and fundamental radiations from radio transmitters which has assisted materially in this connection.

A contract was let during the fiscal year for a radio transmitter that may be operated simultaneously as a radio broadcast transmitter and as a radio range beacon transmitter of the visual type. This equipment is scheduled for delivery in November, 1931, and arrangements are being made for a thorough testing in order to determine the practicability of altering the present airways radio equipment for operation in this manner.

At the close of the fiscal year there were 10 radio engineers, and 31 radio electricians and mechanics engaged in construction, installation, and maintenance of radio equipment.

IMPROVEMENTS IN AIRWAYS EQUIPMENT

The airways standard electric code beacon was improved by substituting two 360° sections of half height in the lower-lens element for the three 120° segments of full height used heretofore. This newly designed lens made possible the elimination of the three vertical astragals which obstructed to some extent the light beam. Mogul prefocus sockets were substituted in rotating beacons, code beacons, and course lights for the mogul screw for the purpose of assuring accurate focussing of the light units at all times.

A new type boundary and obstruction light globe, considerably more efficient than the old type globe, was developed. The new globe has an improved vertical light distribution, in that the light transmitted to a pilot approaching at an altitude of 500 feet appears of equal intensity from a point of 500 feet altitude and 4,000 feet distant to a point directly over the light and 1,000 feet above it.

The design of standard airways beacon towers has been improved to obtain a stronger and more rigid structure, and provision has been made for the installation of course lights or a code beacon by the addition of an auxiliary platform above the rotating beacon.

Airport traffic signal lights have been developed by means of which colored-light code signals can be flashed to pilots approaching landing areas. Time switches with special features for use with 3-kilovolt-amperes engine-alternator sets have been developed.

A water-repellent and mildew-proof treatment has been developed for wind cone sock fabric which will increase the life of the material. New color schemes have been adopted for the painting of airways structures in order to provide suitable contrasts with ground colors prevalent in various sections of the country. New and improved airways keeper's quarters have been designed.

A special system of low altitude side lighting was developed for use in the Columbia River Gorge, where extremely low ceilings prevail at times. The system adopted includes the use of stand-by lights fed by storage batteries during periods of commercial power failure.

A new directional arrow, fabricated of galvanized metal, has been developed. This arrow can be moved readily, and as it is elevated

several feet above ground will be always visible except during exceptionally heavy snowfall.

A new wind indicator has been developed which shows by lighted wind tees both direction and velocity of the wind.

AERONAUTIC DEVELOPMENT SERVICE

The aeronautic development service embraces all activities in connection with assisting communities in the selection and development of airports, the rating of airports, the promotion and correlation of aeronautic research, the publication and dissemination of aeronautic information, and the general promotion work of the department looking toward the development of civil aeronautics.

The service is divided into an aeronautic information division, an aeronautics research division, an airport section, an airways-mapping section, and a section devoted to special research committees.

AERONAUTIC INFORMATION DIVISION

As the contact office between the Aeronautics Branch, the aeronautic industry, and the general public, the aeronautic information division is charged with many of the promotion duties covered by the air commerce act of 1926.

Specifically these duties include—

The publication and dissemination of current information relating to civil aeronautics through the semimonthly periodical, Air Commerce Bulletin.

The publication of airway bulletins describing airports, Department of Commerce intermediate landing fields; airways, air markings, meteorological conditions, special warnings, and other data essential to air navigation.

The preparation and editing of nonperiodic publications known as Aeronautics Bulletins, which are issued from time to time on specific phases of civil aeronautics of both a technical and nontechnical character.

The preparation and dissemination of information for the aeronautic trade journals, and newspapers maintaining special aeronautic columns, departments, or sections.

The compilation and publication of statistics covering accidents to civil aircraft and other statistics on the manufacture and operation of civil aircraft.

The activities of the aeronautic information division now are distributed as follows: Editorial section, statistics and distribution section, Airway Bulletin section, and aeronautics reference library.

EDITORIAL SECTION

One of the most important functions of the editorial section is the publication of the Air Commerce Bulletin, a semimonthly bulletin which goes to a mailing list of approximately 13,000 individuals, libraries, corporations, airports, and others interested in aeronautics. It is the purpose of this publication to make available promptly, and in a convenient form, accurate and official information that is collected by the Aeronautics Branch. As the Air Commerce Bulletin is an official contact of the Aeronautics Branch with the public, news of

Aeronautics Branch projects is emphasized, but other information of value to those interested in aeronautics also is published.

In addition to articles and news items on aeronautical topics, the Air Commerce Bulletin carries regularly notices to airmen and aircraft operators; information as to licenses, identifications, and approvals issued by the Aeronautics Branch; and a summary of the operations of United States air-transport routes.

Under the heading "Notices to airmen and aircraft operators" are published notices of airport and airway changes and warnings, airway progress, radio and communications, airport ratings, new airway bulletins and airway bulletins withdrawn from circulation, new airway maps and aviation charts, certified aeronautical lights, recent air markings, proposed airports, and airports no longer proposed.

Under "Licenses, identifications, and approvals" the reader will find a summary setting forth the number of licenses and certificates that are in force in the various classifications in which these are issued by the Aeronautics Branch, and also notices of new approved type certificates, revisions in approved type certificates, and approvals without approved type certificates.

The information on air-transport routes is carried in tabular form. The table "United States air transport routes" indicates the routes and shows for each route in operation the number of airway miles, type of service (passengers, mail, express, or combinations), number of trips daily, plane miles scheduled daily, date of beginning service, and name of the operator. Airway miles, airplane miles scheduled, and number of companies operating are given in totals for domestic routes, for American-operated foreign routes and for all routes operated by American operators.

During the fiscal year 1931, 21 aeronautics bulletins and 3 other publications were written or revised and sent to the printer.

A complete list of aeronautics bulletins and other aeronautic publications, with notations showing publications written or revised during the year, follows.

Aeronautics bulletins

1. Civil Aeronautics in the United States.[1]
2. Airport Design and Construction.[2]
3. Aeronautics Trade Directory.[1]
4. Air Marking.
5. Airports and Landing Fields.[1]
6. Aeronautic Publications.[3]
7. Air Commerce Regulations.[1]

7–A. Airworthiness Requirements of Air Commerce Regulations for Aircraft.[1]
7–B. School Supplement of Air Commerce Regulations.[1]
7–C. Regulations Governing Entry and Clearance of Aircraft. (Department of Commerce rules only.)[1]
7–D. Parachute Supplement of Air Commerce Regulations.[1]
7–E. Air Commerce Regulations Governing Scheduled Operation of Interstate Passenger Air Transport Services.
7–F. Air Commerce Regulations for Aircraft Components and Accessories. (In preparation, tentative title.)
7–G. Airworthiness Requirements of Air Commerce Regulations for Engines and Propellers.[2]

[1] Revised during fiscal year.
[2] Written during fiscal year.
[3] Revised twice during fiscal year.

7–H. Air Commerce Regulations Governing Alterations and Repairs to Licensed Aircraft.[2]
8. Airway Map of the United States.[3]
9. Establishment and Certification of Aeronautical Lights and Recommended Standards for Marking Obstructions to Air Navigation.
10. Air Navigation Maps.[1]
11. Establishment and Operation of Department of Commerce Intermediate Landing Fields.[1]
12. Aircraft Engine Testing.
13. Civil Air Accidents and Casualties. (In preparation.)
14. Relative Lift Distribution in any Biplane.
15. Control of Airplanes at Low Speeds by Means of Conventional Ailerons.[2]
16. Airport Rating Regulations.
17. Airport Management.
18. State Aeronautical Legislation and Compilation of State Laws. (Out of print.)
19. Aviation Training.[1]
20. Suggested City or County Aeronautics Ordinance and Uniform Field Rules for Airports.
21. Trend in Airplane Design as Indicated by Approved Type Certificates.[2]
22. Gliders and Gliding.[2]
23. Medical Examiners of the Aeronautics Branch.[1]
24. The Federal Airways System.[2]
25. Reduction of Airplane Noise.[2]

Other aeronautic publications·

First Report of Liaison Committee on Aeronautic Radio Research.
Report of Fact Finding Committee on Control of Airplane Hangar Fires by Automatic Application of Water.[2]
Report of Committee on Airport Zoning and Eminent Domain.[2]
Proceedings of the National Conference on Uniform Aeronautic Regulatory Laws.

In keeping with the promotional obligations of the Aeronautics Branch, this section also assists in the preparation of articles on various phases of aeronautics for newspapers and magazines and personal and radio addresses.

STATISTICS AND DISTRIBUTION SECTION

The function of the statistics and distribution section is to collect, compile, analyze, and disseminate statistical data and other useful information on aircraft and engine production and the value thereof; scheduled air transport and miscellaneous flying operations and activities; civil aircraft accidents and casualties; licensed and unlicensed aircraft; licenses for pilots and mechanics; and approvals issued by the Aeronautics Branch for aircraft, engines, equipment, accessories, and various other items.

This section is also responsible for the preparation and handling of correspondence that is not of such a nature as to require the attention of one of the special or technical sections of the branch; the distribution of all publications of the Aeronautics Branch; maintaining liaison with information offices of other Government bodies and associations engaged in aeronautics; and contacting, interviewing, and assisting executives and members of the industry, operators, finance, insurance and actuarial companies, the general public, etc., interested in the promotion and progress of civil and commercial aeronautics.

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[1] Revised during fiscal year.
[2] Written during fiscal year.
[3] Revised twice during fiscal year.

Aircraft production.—A complete census of the number and value of aircraft, aircraft engines and aircraft equipment manufactured during the calendar year 1930 was made by the section, through the use of an improved questionnaire from which practically 100 per cent returns were received. The report of this study was given widespread circulation.

Aircraft operation.—Statistics on scheduled and miscellaneous flying operations were compiled for both the first and last halves of the fiscal year. The data required for these statistical studies were collected by means of forms prepared by the section and filled out by the operators of scheduled air lines, and in the case of the miscellaneous operations by the owners of licensed and unlicensed aircraft.

Civil aircraft accidents and casualties.—Statistics on civil aircraft accidents and casualties were compiled from the records furnished by the accident board.

Previous to the semiannual report July–December, 1930, accidents occurring in all operations were analyzed and published in one report. Now, however, the scheduled air transport and miscellaneous flying operations are treated in separate reports, in recognition of the fact that the two types of operations are conducted on different premises. Scheduled air transport includes those operations in which aircraft carry passengers, mail, and express over fixed routes at regular intervals, as distinguished from miscellaneous operations, such as experimental, student instruction, commercial or industrial, and pleasure flying. Not only have the two general types of flying activities been divided, but miscellaneous operations were further broken down into the main four subdivisions, namely, student instruction, experimental, commercial or industrial, and pleasure flying. This method of compilation, analysis, and publication was instituted during the last 6-month period of 1930.

Correspondence and distribution of publications.—The correspondence handled during the past fiscal year was maintained at approximately the same volume as for the previous year, while the distribution of bulletins and publications has increased appreciably. More than 336,000 bulletins have been sent out in response to letters received and in general distribution as compared with 300,000 last year. The number of forms and application blanks distributed have been reduced substantially as individual requests for this material are now being handled by the Aeronautics Branch inspection districts.

In numerous instances during the year the necessity for dictated replies to inquiries was eliminated by the new and revised bulletins designed to meet the demand for general aeronautical information and by the use of suitable form letters in cases where feasible. A very definite change in the character of requests received has been evident during this fiscal year. The increased familiarity of the general public with the different phases of aeronautics has resulted in more specific and detailed inquiries which require more time and research for the preparation of replies.

On June 30, 1931, the mailing list for aeronautics bulletins included 8,193 names, and for the Air Commerce Bulletin the list numbered 12,768.

General information and summary.—The statistical research work of this section has kept pace in growth and development with civil aeronautics in the United States.

The section has installed a complete file of aircraft, pilot, and mechanic licenses, and identification marks issued for unlicensed aircraft. From these current records a quarterly statement is compiled giving the status of licenses by classes and States.

A concise technical-description file of engineering approvals also has been established from which daily, weekly, and semimonthly lists are prepared for general distribution. These lists are also supplied to the Aeronautics Branch inspectors for their information and guidance.

AIRWAY BULLETIN SECTION

This section is charged with maintaining up-to-date records of all airports and landing fields in the United States, together with records of proposed airports and airports under construction.

The airway bulletin section also publishes illustrated loose-leaf sheets describing airports, Department of Commerce intermediate landing fields, special warnings of unusual conditions that might affect the safety of flight, airways of the country, meteorological conditions, and other data essential to air navigation.

Airway bulletins contain two maps, one of the airport itself showing a wind rose for the locality concerned, the immediately surrounding terrain, dimensions of the landing area, obstructions to approaches, markings, positions of available facilities, etc., and the other showing the airport's location with respect to near-by railroads, rivers, and the supporting community. In addition, the text portion of these bulletins gives the name of the airport, its class, method of operation, latitude and longitude, altitude above sea level, description of surface and runways, location and nature of obstructions, method of marking and identification, description of lighting equipment, accommodations for aircraft and air travelers, meteorological data, and other information desired by pilots or aircraft operators.

During the past year 250 new airway bulletins were issued 146, revised, and 101 reprinted. These airway bulletins are distributed to a mailing list of 3,500 individuals, organizations, and others interested.

A total of 1,259 airway bulletins has now been published and records at the close of the fiscal year show 1,863 airports and landing fields actively in operation and 675 cities having under advisement the establishment of airports.

During the fiscal year the airway bulletin section maintained communication with more than 5,000 chambers of commerce, municipal airport committees, civic officials, airport owners, aircraft operators, and others engaged in or directly interested in the operation of airports. Approximately 20,000 letters were written to these and other contacts soliciting information concerning airports. In addition, some 5,000 letters of a general nature requesting specific information relative to the Federal airways system, airport, and allied matters were answered.

Before the close of the fiscal year the airway bulletin section commenced the compilation of material for two new bulletins, which are designed to supersede the loose-leaf sheets. The first of the bulletins is to contain illustrated information of particular value to pilots. Data to be included embrace charts showing locations of the radio

aids, beacon lights and intermediate fields operated by the Department of Commerce, meteorological summaries of the United States, tabulations of special aeronautical weather services available, and much other material of value to those in the air. The second bulletin is to contain in digested form written summaries describing all airports and landing fields in the United States of record with the department. In this bulletin pilots will have under one cover, readily available for reference, data on all airports and landing fields in the country. It is expected that these two new bulletins will be published early in the fiscal year 1932.

AERONAUTICS REFERENCE LIBRARY

The aeronautics reference library is maintained, primarily, for personnel of the Aeronautics Branch although it is now being used extensively by persons outside the branch who are engaged in aeronautical research work.

Much valuable material has been added to the library during the past year. It now contains 500 books, a file of technical reports and documents issued by the several Government agencies having to do with aeronautics, aeronautic magazines and official organs, and reports from the industry, besides a large number of foreign reports and documents pertaining to aeronautics. The material in these publications is indexed and a semimonthly library bulletin is issued.

Publications received during the fiscal year numbered 4,268; 521 magazines and reports were indexed, and 285 books and documents were catalogued.

AERONAUTICS RESEARCH DIVISION

The aeronautics research division is engaged in a research program directed toward the development and improvement of aids to air navigation and the promotion of safety and comfort in flight. Its activities are divided among the following sections: Radio section, lighting section, aircraft-engine section, wind-tunnel section, and engineering section.

RADIO SECTION

The research work on the use of radio in aeronautics was devoted principally to the development of a combined transmitter for the simultaneous transmission of radiotelephone weather broadcasts and visual-type radio range beacon signals on the same radio-frequency, a complete system of radio aids to facilitate blind landing of aircraft, a new improved type visual beacon course indicator, a simple direction finder for aircraft, and receiving equipment for aircraft. Also, preliminary work was begun on radio methods and equipment for the prevention of collision between aircraft in conditions of low or zero visibility.

Simultaneous phone and range beacon transmitter.—The development of this type of transmitter was completed, and numerous flight tests were made to check and demonstrate its operation. With this transmitter the pilot receives the radio range beacon service and weather or other telephonic information simultaneously on the same medium-frequency aircraft receiving set, without either limiting or interfering with the other. Such an arrangement is especially de-

sirable under adverse weather conditions when both services are most needed.

Blind-landing aids.—Improvements were made in the operation of the transmitting and receiving equipment constituting the radio system of aids for the blind landing of aircraft. In particular, a combined instrument was developed for use on the airplane which indicates by a single reading the relative position of the airplane with respect to the landing runway as well as with respect to the proper curved landing path. An improved marker beacon for defining the landing-field boundaries was also developed. Work was begun on adapting the system to permit the pilot to land into the wind regardless of the wind direction at the airport. A dual-control airplane was completely equipped with the necessary radio equipment and aircraft instruments and provided with a hood over the pilot's cockpit to permit actual blind flights on the system. Numerous preliminary tests were made.

Improved type visual beacon course indicator.—A new course indicator was developed for use with the visual-type radio range beacon which utilizes the selectivity of the vibrating reeds but permits the pilot to receive the beacon course indications on a zero-center pointer-type instrument similar to that employed with the earth-inductor compass. This indicator may be found more convenient by pilots than the regular reed indicator with its two white lines. It affords operational advantages over the reed indicator; namely, that the instrument is of standard aircraft size, it may be more readily combined with other aircraft instruments, and the sharpness of course indication may be controlled by the pilot. Specifications were prepared for the construction of the new device, and submitted to interested manufacturers.

Aircraft direction finder.—Simplifications and improvements were made in the aircraft direction finder under development. The new design is such that an ordinary receiving set having the proper frequency range may be readily converted for direction-finding operation by the addition of simple input and output units. A single-loop antenna is employed. In the interests of simplified design, visual indication only is provided. Means are provided for using the direction finder as a navigation device (that is, for taking cross bearings) in addition to its use as a homing device.

Aircraft receiving equipment.—A device called a deviometer, suitable for use with either the reed indicator or the new type course indicator, was developed. This device permits a pilot to follow any chosen course, within 15°, on either side of the fixed beacon course.

Improvements were made in the automatic volume control for the visual type range beacon so that the pilot may obtain a sense of approach as he nears a given beacon station.

A symmetrical longitudinal T-type receiving antenna for use on aircraft was developed and exhaustively studied. This antenna is free from course errors in radio range beacon reception and is at the same time superior to the conventional pole-type antenna structurally, and in respect to ice formation, mechanical features, and aerodynamic resistance.

The design of a receiving set having suitable electrical characteristics and automatic volume control for reception of the combined signals from the simultaneous phone and beacon was begun.

Collision prevention.—Preliminary work was done on the development of a radio system to aid in preventing collisions between aircraft when flying under adverse conditions of visibility. The aim is to give automatic warning to an airplane of the presence and approximate position of any other airplane within a radius of about 3 miles from it. The system involves the continuous transmission of ultra-high-frequency radio waves from each airplane. Directivity of reception or transmission, or both, will inform the pilot of the direction of danger. The development of ultrahigh-frequency equipment sufficiently rugged and reliable for use on aircraft is a difficult problem.

LIGHTING SECTION

Airplane running lights.—A theoretically ideal candlepower distribution curve for airplane running lights has been worked out mathematically. This distribution takes account of the speed of the airplane and the effects of low visibility. The design of the reflector developed last year (see Air Commerce Bulletin, March 15, 1930) has been modified so as to give this distribution, and an experimental reflector is being made up in the Bureau of Standards shops. To afford a basis of comparison with running lights now in use, candlepower distribution measurements have been made on commercial running lights. These units include both new and used pyralin running lights, and two types of glass running lights. Distribution measurements have also been made for the Navy Department on a new type of glass running lights developed by that department.

Aeronautical code light characteristics.—An investigation is going forward to determine the minimum length of dots, dashes, and eclipses which can be used in code signals without risk of confusion. Short signals are desirable on account of the increasing number of airports which frequently makes it necessary to assign 2-letter characteristics to identify airports. The time available for such characteristics is limited by the eclipse interval of the main beacon. It has been found that the articulation of fast signals depends upon the flashing mechanism used. An improvement in the flashing mechanism commonly used for aviation code lights has been made which will make possible higher-speed signals. Work is also being done to determine the time of heating and cooling of the lamp filaments used in areonautical code lights.

Airway beacons.—Photometric measurements were made in connection with the development of the new 36-inch airways beacon, and a 300-meter photometric range has been constructed on the grounds of the Bureau of Standards, primarily for the purpose of analyzing the candlepower distribution of this beacon. Visibility tests and candlepower distribution measurements on various beacon lights have been made to afford a sound experimental basis for the regulations relative to aeronautical lights.

Air traffic control projector.—A traffic-control projector for use at airports is in process of development. This projector is very light and may be easily handled, even in a strong wind. It is designed to give either green or red signals at the election of the operator. These signals are of high intensity and are readily visible at a distance of 1½ miles in daylight, even against an unfavorable background. Arrangements are being made to put the device to practical service tests.

Specifications for the colors of aviation glasses.—Tentative specifications for red and green glass have been furnished the airways division. Work is now in progress to determine whether it is possible to increase the transmission of colored glass without causing the colors to become indefinite for the normal observer. This requires an extended series of visibility tests with a number of observers.

Committee activities.—Through membership in the appropriate committee of the Illuminating Engineering Society the section has participated in the drafting of the definitions for terms relating primarily to aviation lighting and in the preparation of reports for the International Commission on Illumination, summarizing aviation lighting research in this country, which will be presented at an international conference in England in September. A comprehensive paper analyzing the results of researches on the transmission of light through fog will also be presented at the international conference.

AIRCRAFT ENGINE SECTION

Experimental work carried on during the year by the aircraft engine section has resulted in considerable improvement in the operation of the mercury scales used to measure engine torque. A new type of mechanical scale has also been designed and built. Comparative tests may show that the latter is preferable to the mercury scales for use with engines of low power.

Test runs are in progress to study further the efficiency of air-straightening grids which are used between the propeller and the engine to eliminate the effect of windage on the observed torque. A new design of grid as well as several small grid sections have been built for use in this work.

In connection with the fuel requirements of aircraft engines, preliminary experiments on five aviation gasolines ranging from below 60 to above 80 octane number were undertaken in cooperation with the Army, the Navy, and four industrial laboratories. The fuels were rated by a variety of available methods and the results showed that the knock rating assigned to an aviation gasoline depends on the test method and equipment used. Further work must be done to determine the particular method of test which gives ratings most indicative of the detonation characteristics of fuels under flight conditions.

WIND-TUNNEL SECTION

During the year an aeronautics bulletin has been prepared on The Control of Airplanes at Low Speeds by Means of Conventional Ailerons. This bulletin contains a summary of the measurements on ailerons of varying span and chord which were presented in a more technical manner in Technical Reports 298, 343, and 370 of the National Advisory Committee for Aeronautics. As a result of these publications, certain questions have been raised by the industry, namely, as to the magnitude of the interference effect between ailerons on opposite wing tips, and as to the effect of aileron displacement on the lift, drag, and center of pressure of the main wing. These questions are being investigated and most of the experimental work has been completed.

Measurements have been made of the characteristics of rudders of varying size at large angles of attack. The yawing moments produced by seven rudders have been measured for three fuselage

models for rudder angles up to 44° and for angles of attack up to 40°. The results of these measurements are being prepared for publication.

ENGINEERING SECTION

Reduction of noise in airplanes.—The work on this continuing project has been concentrated during the past year on the problem of mufflers for airplane engines. A Hispano-Suiza engine capable of delivering 200 horsepower has been mounted on a test stand at the Arlington laboratory. The engine is water-cooled and the power is absorbed by a hydraulic dynamometer which is relatively quiet. In this way propeller noise is eliminated, and the conditions are made most favorable for the study of mufflers. The noise is measured instrumentally by means of a calibrated condenser microphone, an attenuator, a portable amplifier, and a current-measuring device. The effect of the muffler on the power output of the engine is measured by the dynamometer. In order to give a standard of performance as regards noise reduction, provision is made in the set-up to pipe the exhaust, when desired, to underground tanks, with water cooling. Such an arrangement reduces the exhaust noise to a minimum.

The cooperation of the industry was invited by announcement in the press, especially in submitting mufflers for test. As a result, three mufflers have been sent in, and others are promised. In addition, the department's engineers have designed experimental mufflers, and testing has been started. The results obtained so far indicate (1) that the noise level is still high, even when the exhaust noise is eliminated, due to the noise of the valve gear and other sources; (2) that the reduction obtained depends on the position of the observer with respect to the engine and muffler; and (3) that the use of manifolds gives a considerable reduction in noise. The study will be continued during the coming year.

Crash-resistant fuel tanks.—The possibility of increasing the resistance of fuel tanks to rupture, or at least of avoiding the deluge of fuel, has been under study. Preliminary experiments were made by dropping 10-gallon cans on a concrete surface, and some data were obtained on the effect of altitude and of certain types of protection. These tests were supplemented by dropping actual fuel tanks, several of 200-gallon capacity.

A new elastic and strong synthetic material having many of the properties of rubber, but insoluble in gasoline or oil, was found to offer great possibilities when used inside the tank. Experiments have been completed only for the 10-gallon cans, but the results were very encouraging. There are many problems to solve before the use of this material can be considered practical, but the possibility of a real advance in making fuel tanks crash resistant seems present.

Welded aircraft joints.—The study of aircraft joints has been continued with the cooperation of the National Advisory Committee for Aeronautics. The program in progress consists of the study of welded joints in chrome-molybdenum steel tubing which are reinforced by gusset plates, the study of welded joints in thin-walled tubing, and the study of reinforced joints which have been heat treated after welding. The very extensive preliminary work, consisting of tensile and hardness measurements on each piece of tubing and gusset plating and the machining of specimens, has been completed. The welding of the specimens, under procedure control, has been started.

AIRPORT SECTION

The airport section is the point of contact between the Aeronautics Branch and the public and private airports of the country. Its primary function is to foster and encourage the development of airports and this work has met a distinct need in supplying information to cities, towns, counties, etc., engaged in the development of airports. This is particularly true in the small communities where the local sponsors usually are not familiar with the problems involved.

The number of airports and landing fields in the United States on June 30, 1931, was as follows:

Total number of airports and landing fields (Army, Navy, municipal, commercial, Department of Commerce intermediate and marked auxiliary fields)	1,860
Municipal airports	577
Commercial airports	601
Department of Commerce intermediate landing fields	350
Army airdromes	57
Naval air stations (including Marine and Coast Guard)	12
State-operated fields	2
Marked auxiliary fields	259
Fields for miscellaneous Government activities	2
Proposed airports	541
Airports and landing fields having any night lighting equipment	649

Field advisory service.—This service, which is rendered upon request without charge, includes conferences with States, counties, municipalities, and civic and trade organizations desiring assistance in the selection of airport sites and requesting information regarding requirements for the development of suitable airports. Four airport specialists, supplemented by the chief of the section, are available for this work. During the past fiscal year 664 visits were made by these men in an advisory or rating capacity and 73 talks in the interest of airport development given.

The 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 the officials interested in the development of airports and desiring information regarding the requirements of the Airport Rating Regulations of the Department of Commerce. In addition to visiting the cities requesting service, many fields on which the department has published airway bulletins were inspected to check the information contained in these bulletins.

Airport specialists do not in any case render detailed engineering service, but do urge the importance of having experienced engineers make comprehensive studies and prepare plans for complete airport development in order that every dollar invested in the project may be expended to the best advantage.

Rating of airports.—The Aeronautics Branch is charged under the law with the examination and rating of air navigation facilities. Under this authority, requirements for the various airport ratings granted by the Government have been promulgated. At the end of the fiscal year eight airports had been rated, all but one receiving the highest, or A–1–A, rating. That so few have been rated is accounted for by the fact that in their present stage of development the majority of the airports have not yet met all the requirements for the particular rating desired.

The rating of airports is undertaken in order that pilots and aircraft operators may know at a glance that certain minimum requirements have been met as to general equipment and facilities, effective landing area, and aeronautic lighting equipment, and that certain essential features from the standpoint of safety of operations are available. Hundreds of airports are engaged in construction programs leading to the highest ratings. Also, it is felt that the Airport Rating Regulations are making a definite contribution to airport development by suggesting to airport committees and other bodies of laymen responsible for or interested in airport projects, various facilities essential to the safety and efficiency of the airport which otherwise would be provided only through considerable effort on the part of the industry.

Work of a special nature.—Numerous conferences are held in the Washington office with State and local officials and individuals interested in airport development or in the manufacture of the varied equipment that is required by the modern airport. The Airport Rating Regulations are revised periodically to keep abreast of changes in the rapidly moving industry. Considerable work has been done by the section on the preparation of an aeronautics bulletin entitled "Design and Construction of Airports." Information of interest and value to the industry on the amount of money invested in airports and the anticipated expenditures for 1931 was obtained by this section and published in the Air Commerce Bulletin of February 2, 1931. A survey to determine the sums appropriated by State governments for the development of any ground facilities is in progress.

In addition to the regular work, members of the airport section have served on the following research committees: Airport traffic control, airport zoning and eminent domain, and airport drainage and surfacing.

AIRWAYS-MAPPING SECTION

This activity of the Aeronautics Branch is carried on by the airways-mapping section of the Coast and Geodetic Survey. The mapping program includes two series of maps: Sectional airway maps and strip airway maps.

Sectional airway maps.—Three maps have been flight checked and printed:

Upper K–16. Milwaukee.
Lower K–16. Chicago.
Upper K–17. Detroit-Toronto.

Nomenclature of sectional airway maps.—A name has been added to each map to supplement the letter and number coordinates. Those interested in airway maps will better understand the location of a map if some city or other prominent feature is mentioned as being included within the limits of the map.

The following sectional airway maps have been in process of compilation during the year:

Upper I–11. Los Angeles.
Upper I–12. Prescott.
Upper I–13. Albuquerque.
Upper I–14. Oklahoma City.
Lower I–14. Dallas.
Lower J–14. Wichita.
Upper J–16. Indianapolis.
Lower K–17. Cleveland.
Upper K–18. Rochester.
Lower K–18. New York.
Upper J–18. Washington, D. C.

Strip airway maps.—The compilation program for strip airway maps was continued to a limited extent during the year in order to

prepare the maps of certain routes more quickly than could have been done by compiling the sectional airway maps of the localities.

The compilations of the following strip airway maps have been completed during the fiscal year and printed, all to a scale of 1:500,000:

No.	No.
122. Albany-Montreal.	143. Atlanta-Nashville.
126. Jacksonville-Atlanta.	144. Nashville-Evansville.
137. Portland-Spokane.	150. Kansas City-Omaha.

A special detail map of the Columbia River Gorge was printed on the back of map No. 137 and was numbered 137–A, for office records only. This was designed primarily to allow the plotting of the special lighting through the gorge.

Strip airway map No. 149, Tulsa-Ponca City, ready for printing, was canceled, but the compilation is to be used in the preparation of sectional airway map Lower J–14, Wichita, the work on which has been started.

Distribution of airway maps and charts.—The number of maps distributed by the Department of Commerce for the fiscal years 1930 and 1931, issued through the office of the Coast and Geodetic Survey, follows:

	1930	1931
Department of Commerce airway maps	12,004	17,555
Army air navigation maps	13,657	9,474
Navy aviation charts	731	579
Total	26,392	27,608

The smaller number of Navy aviation charts issued during 1931, as far as this list shows, is explained by the fact that after September 18, 1929, the larger orders were filled by the Hydrographic Office and only a few were sold by the Coast and Geodetic Survey.

New editions.—The demand for Department of Commerce airway maps necessitated reprints of the following strip maps:

No.	No.
103. Oklahoma City-Wichita.	132. Los Angeles-Las Vegas.
119. Buffalo-Albany.	133. Las Vegas-Milford.
129. Greensboro-Richmond.	134. Milford-Salt Lake City.

SPECIAL RESEARCH COMMITTEES

The Aeronautics Branch has organized a number of special cooperative research committees under the chairmanship of the director of aeronautic development for the purpose of investigating and reporting on certain outstanding problems. Summaries of the accomplishments of those committees, which were active during the fiscal year, follow:

COMMITTEE ON AIRPORT TRAFFIC CONTROL

This committee originally was organized in the fall of 1929 as the committee on standard signal systems for airports. However, the scope of its work has been increased and the name changed to committee on airport traffic control. It is composed of representatives of the Aeronautics Branch and the Bureau of Standards of the

Commerce Department; the Army Air Corps; the Bureau of Aeronautics, Navy Department; the National Advisory Committee for Aeronautics; and the Aeronautical Chamber of Commerce of America (Inc.).

In undertaking its studies, the committee was impressed with the basic necessity of uniformity throughout the country in (*a*) airport field rules and (*b*) signals employed to control traffic at airports. It also realized that in a new field, developing as rapidly as air transportation, it is impossible to predict ultimate requirements and establish hard and fast conclusions. At the same time, it recognized that a start should be made at once along sound lines that would permit a step-by-step development to meet new requirements as they arise.

A survey has been made of traffic conditions at foreign and American airports. Numerous suggestions have been received from engineers, manufacturers, and operators as a result of a general invitation extended through the press. Questionnaires were sent to managers of representative airports of the United States asking for information regarding air-traffic conditions at their respective ports and means employed for controlling such traffic, and requesting suggestions as to a suitable uniform traffic-control system.

All of the suggestions and other information received from these several sources have been carefully classified and analyzed by the committee. At the same time the committee has been conducting at Bolling Field, D. C., a series of tests of various types of visual signaling units under both day and night conditions.

A preliminary report has been published by the committee, setting forth in detail the information outlined in the foregoing. Further studies are now being made with the cooperation of more than a score of local subcommittees, organized throughout the United States at cities where important airports are located. In preparation of their individual reports to the full committee, the subcommittees will study airplane movements to and from airports to determine existing traffic conditions and periods of greatest density in traffic; estimate the volume and maximum density of the traffic that probably will be passing through the various airports in the next three to five years; study the landing area layouts from the standpoint of traffic flow and the suitability of servicing and terminal arrangements; make time studies of airport traffic operations in order to determine the delay points; and draw up recommendations as to the extent and character of signal systems which seem necessary or desirable in connection with control of airport traffic.

COMMITTEE ON AIRPORT DRAINAGE AND SURFACING

The absence of uniform and thorough applications of adequate drainage and surfacing for airports has been responsible for accidents to planes in landing and taking off from airports and landing fields, for delays and interruptions in departures and arrivals of aircraft, and has involved the wastage of thousands of dollars in time and money in connection with airport projects.

To undertake the solution of the problems of drainage and surfacing in so far as they relate to airport engineering and construction, the technical resources of the American Engineering Council, the American Road Builders' Association, and the Aeronautics Branch

have been joined into one group, and these organizations have designated representatives to serve on a committee on airport drainage and surfacing organized in June, 1930.

Two questionnaires distributed by the committee have elicited valuable information and suggestions. One of these questionnaires was placed in the hands of airport managers to obtain information on practices now prevailing and results obtained. The other, submitted to local engineering committees organized throughout the United States by the American Engineering Council, was so designed as not only to bring out that which is best in current practice, but also to draw on the knowledge and employ the ability and initiative of some of the best engineering talent in the country, to the end that the problems might be brought nearer to a satisfactory solution. In addition, the special research engineer of the committee made an inspection tour covering representative airports in all parts of the country, interviewing engineers, airport managers, pilots, and operators and making a comprehensive study of airport problems and practices in the various sections of the country.

The committee is now engaged in the preparation of its report, which will be printed by the Aeronautics Branch and made available to all who may be interested.

COMMITTEE ON AIRPORT ZONING AND EMINENT DOMAIN

The organization of a cooperative committee on airport zoning and eminent domain on March 11, 1930, was the result of many requests received from city officials, airport managers and engineers, and others interested in the development of adequate airports for information and suggestions as to suitable airport-zoning ordinances to insure protection to the flying public against hazards that might be developed in the vicinity of airports.

This committee consists of representatives of the Aeronautics Branch, the Bureau of Standards, and the advisory committee on city planning and zoning of the Department of Commerce; the air transport section and the airport section of the Aeronautical Chamber of Commerce of America; the committee on aeronautical law of the American Bar Association; the National Conference on City Planning; the Planning Foundation of America; and the Chamber of Commerce of the United States.

The committee's report was published during the fiscal year in the Air Commerce Bulletin, and also was reprinted as a separate publication in December, 1930. A limited number of copies of the report are available free upon request to the Aeronautics Branch and the publication also may be purchased from the Superintendent of Documents, Washington, D. C., at 5 cents per copy.

FACT-FINDING COMMITTEE ON CONTROL OF AIRPLANE HANGAR FIRES BY AUTOMATIC APPLICATION OF WATER

This committee, organized to consider the practicability of applying the principle of automatic issue of water from sprinkler systems to control fires in airplane hangars conducted tests of a number of types of sprinklers by starting fires in a specially constructed hangar con-

taining several obsolete airplanes. Time required for extinguishment of the flames under various conditions with sprinklers of different types was noted, and other pertinent data obtained. These tests were complete during the fiscal year 1930. The report was published during the fiscal year 1931 and now is available free upon request to the Aeronautics Branch.

LIAISON COMMITTEE ON AERONAUTIC RADIO RESEARCH

This committee, which was organized in January, 1930, is a continuing body for the purpose of making surveys of research in progress in the field of aeronautic radio and of those problems calling for research. In addition, the committee determines what steps should be taken to insure the most effective application of research to the needs of aeronautics and recommends suitable research problems.

This committee consists of representatives of the Aeronautics Branch and the Bureau of Standards of the Department of Commerce; the Army Air Corps; the Bureau of Aeronautics, Navy Department; the National Advisory Committee for Aeronautics; the Aeronautical Chamber of Commerce of America; the Institute of Radio Engineers; the National Electrical Manufacturers' Association; and the Radio Manufacturers' Association.

During the year the committee held several informal meetings, which culminated in a 2-day session in Washington and at the Department of Commerce experimental flying field at College Park, Md. The committee now is engaged in the preparation of its second report, the first of which was published in 1930.

ADMINISTRATIVE DIVISION

The administrative division, composed of a personnel unit, an accounting unit, a files unit, and a supply unit, is the service organization for the various divisions and sections of the Aeronautics Branch. The division is specifically charged with the handling of all budget, appropriation, and accounting matters; the handling of appointments of personnel and personnel records; 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 branch.

Funds for carrying on the work of the branch are appropriated under two titles, "Aircraft in commerce" and "Air navigation facilities." The appropriation "Aircraft in commerce" is used for salaries and traveling expenses of inspectors engaged in the inspection and licensing of aircraft and airmen, for salaries of employees necessary to carry on the work in the Washington office and in the field offices, for the testing of aircraft engines, and for certain research work conducted at the Bureau of Standards.

The appropriation "Air navigation facilities" is used primarily for the construction and maintenance of civil airways. A portion of this appropriation is, however, used for the preparation of maps used by airmen, for the carrying on of certain research and experimental work looking toward the development of aids to air navigation, and for the airport consultation and airport rating activities of the department.

Following is a tabulation of the amounts that have been appropriated under these two heads since the Aeronautics Branch began to function:

TABLE 5

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
1931	1,260,830	7,944,000	9,204,830
1932	1,369,660	8,992,640	10,362,300

[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.

The personnel paid from the appropriation "Aircraft in commerce" for the past five years is as follows:

TABLE 6

Date	District of Columbia	Field	Total
June 30, 1927	51	37	88
June 30, 1928	104	68	172
June 30, 1929	146	127	273
June 30, 1930	166	150	316
June 30, 1931	175	136	311

During the year the filing systems of each of the nine field offices have been completely revised and a standard installation made in each district. During the year the Aeronautics Branch purchased $180,585 worth of accountable property, which included five airplanes and three airplane engines. A total of 295,052 pieces of mail was received and 817,381 dispatched during the year, and in addition to this correspondence 7,144 telegrams were received and 5,456 were dispatched during the 12 months ended June 30.

SUMMARY AND CONCLUSIONS

The work of the Aeronautics Branch during the fiscal year ended June 30, 1931, has been directed, as in the past, toward the further development of the aircraft industry and the further promotion of civil aeronautics in the United States.

Outstanding in this regard has been the expansion of the Federal airways system which, when completed, will embrace 25,000 miles of airways fully equipped with aids to air navigation for the safe operation of aircraft both day and night. At present there are 17,500 miles of airways lighted and under construction which are or will be equipped with radio direction and communication facilities and weather-reporting services. Including the 2,000 miles of lighted airways authorized for the ensuing year, the airway program now embraces 19,500 miles. However, the 2,000 miles authorized for the fiscal year 1932 have not yet been allocated, but steps in this direction will soon be taken, and during the year this mileage will become part of the Federal airways system.

In addition to the foregoing, there are 1,123 miles of airways which have been or are being provided with certain air-navigation facilities for day operations. Portions of this mileage will be lighted during the ensuing fiscal year, and it is possible that some sections will be utilized to bring about minor relocations of airways which experience has indicated will become necessary to better serve the Federal system.

At present there are 48 airways radio-communication stations in operation for the broadcast of weather information to planes in flight at frequent intervals, an increase of 13 over last year, and 10 stations are under construction. Fifty-one radio range beacons are in operation to provide directional guidance by means of radio signals to airmen flying along the airways, an increase of 42 over the previous fiscal year. There are 13 radiobeacons under construction.

At the end of the fiscal year 9,500 miles of automatic telegraph-typewriter circuits for the collection and transmission of weather reports along the airways were in operation, an increase of 3,850 miles over the preceding fiscal year.

Three lighted transcontinental routes are included in the Federal airways program: One, between New York and San Francisco (in operation on day and night schedules); a second, the midcontinental, between New York and Los Angeles; and the third, between New York and San Diego, known as the southern transcontinental. The latter two have been under construction and are rapidly nearing completion. Air-transport companies now are operating passenger, mail, and express services over these three routes.

These transcontinental airways are designed to serve the north, central, and southern sections of the United States from east to west both directly and through feeder routes and connecting routes. Also they not only constitute the basis for air transportation service to a large portion of the country, but at the same time they provide alternate routes for air travel. Further, they are coordinated closely with various border countries and are so designed as to facilitate international travel to the nations of the Western Hemisphere.

RESEARCH WORK

Of immediate and potential value to aeronautics in general is the research work undertaken by the Aeronautics Branch during the fiscal year just closed. Much of this work is centered on aeronautic radio, and at present the problems nearing solution or still under investigation include—

A device for the simultaneous transmission of radiotelephone weather broadcasts and visual-type radio range beacon signals on the same frequency.

A system of radio aids to facilitate blind landings of aircraft.

A new improved type visual radiobeacon course indicator.

A simple direction finder for aircraft.

A device known as a deviometer, which permits a pilot to follow any chosen fixed radiobeacon course within 15° on either side.

Other research problems are directed at the reduction of noise from airplane engine exhausts by the use of mufflers; the development of crash-proof tanks; the control of airplanes at low speeds by means of conventional ailerons; a continuation of the study of welded aircraft joints and research into various phases of aeronautical lighting, in-

cluding airplane running lights, airway beacons, and colors of aviation glasses.

In addition to the foregoing, special research committees of the Aeronautics Branch, organized cooperatively with the industry, are working on problems pertaining to airport traffic control and airport drainage and surfacing. The reports of two other committees, whose work was concluded during the previous fiscal year, were published during the year. One of these committees engaged in a study of the control of hangar fires by the automatic application of water, and the other in a study of airport zoning and eminent domain.

TABLE 7.—*Progress of civil aeronautics in the United States, by calendar years*

	1926	1927	1928	1929	1930
I. Scheduled air transport operations					
Airplanes:					
In service and reserve		[1] 128	[1] 325	[1] 525	[1] 600
Value of		[1] $1,838,462	[1] $7,000,000	[1] $12,000,000	[2] $11,489,450
Airways (all):					
Services in operation	[3] 18	23	63	97	122
Express mileage	4,434	7,233	8,379	11,775	20,445
Mail mileage	8,039	8,223	14,561	26,597	41,501
Passenger mileage	3,715	7,557	11,455	19,730	36,136
Total mileage—					
Domestic	8,252	8,865	15,590	24,865	29,887
Foreign extensions	152	257	1,077	11,456	19,662
Accidents:					
Number of fatal		[4] 4	12	24	9
Miles flown per fatal accident			889,454	1,047,562	4,105,023
Number of nonfatal		[4] 21	74	113	82
Number of passenger fatalities		[4] 2	13	18	24
Passenger-miles flown per passenger fatality					4,322,802
Personnel employed:					
Mechanics and ground crew			[1] 525	[1] 1,182	[1] 1,800
Pilots		[1] 107	[5] 308	[1] 562	[1] 675
Others			[1] 663	[1] 601	[1] 1,000
Total		[1] 462	[6] 1,496	[1] 2,345	[1] 3,475
Express and freight carried—pounds	1,733,090	2,263,580	1,848,156	1,866,879	2,869,255
Fuel (consumed):					
Gasoline—gallons	863,617	1,174,098	2,134,690	6,285,374	14,549,477
Oil—do	43,181	58,705	106,735	314,268	452,952
Mail:					
Carried by contractors—pounds	377,206	1,270,299	4,063,173	7,772,014	8,513,675
Carried by Post Office Department—pounds	[7] 433,649	[7] 383,866	(?)	(?)	(?)
Income to contractors	$765,549	$2,643,454	$7,432,721	$17,042,521	$20,015,969
Income average per scheduled round trip	$295	$654	$994	$1,205	$974
Income average per pound of contract mail	$2.03	$2.08	$2.03	$2.01	$1.60
Income average per pound contract mile flown	$0.39	$0.625	$0.94	$1.06	$0.70
Load, average pounds per scheduled round trip	112	273	489	617	608
Miles of mail airways	8,039	8,223	14,561	26,597	41,501
Total carried—pounds	[7] 810,855	[7] 1,654,165	4,063,173	7,772,014	8,513,675
Miles flown:					
Daily average	11,830	16,083	29,242	68,881	101,220
Mail	[3] 4,240,407	[3] 5,543,578	7,846,296	14,869,166	19,904,185
Total, all operators	4,318,087	5,870,480	10,673,450	25,141,499	36,945,203
Passenger miles flown (one passenger carried 1 mile)					103,747,249
Passengers carried	5,782	8,679	49,713	173,405	417,505
Passenger fare, average per mile	$0.12	$0.106	$0.11	$0.12	$0.083
Pay rate of:					
Mechanics, average per hour				$0.74	$0.74
Mechanics, average per month				$157	$158
Pilots, average per mile in addition to base (day)				$0.05	$0.046
Pilots, average per mile in addition to base (night)				$0.10	$0.096
Pilots, average per month				[8] $550	[8] $460
Revenue to operator:					
Mail contractors	$765,549	$2,643,454	$7,432,721	$17,042,521	$20,015,969
Passenger and express			[9] $599,059	[10] $3,701,465	[11] $5,761,151
Total, all operators (mail, passenger, and express)	[12] $765,549	[12] $2,643,454	[13] $8,031,780	[14] $20,743,986	[11] $25,777,120

Footnotes at end of table.

TABLE 7.—*Progress of civil aeronautics in the United States, by calendar years*—Continued

	1926	1927	1928	1929	1930
II. Miscellaneous flying operations					
Airplanes in operation (licensed and unlicensed)	----------	2,612	4,779	9,315	9,218
Accidents:					
Number of fatal	----------	95	215	287	301
Miles flown per fatal accident	----------	315,789	279,070	383,275	359,700
Number of nonfatal	----------	158	821	1,299	1,732
Number of passenger fatalities	----------	89	210	241	213
Miles flown per passenger fatality	----------	337,079	285,714	456,432	508,309
Fuel (consumed):					
Gasoline—gallons	2,426,028	3,882,351	7,764,702	14,235.243	13,981,331
Oil—do	121,301	194,118	388,235	711,762	700,567
Miles flown	[1] 18,746,640	[1] 30,000,000	[1] 60,000,000	[1] 110,000,000	[1] 108,269,760
Passengers:					
Carried for hire	[1] 676,657	([15])	([15])	[1] 1,732,752	[1] 1,840,492
Carried for pleasure	[1] 94.353	([15])	([15])	[1] 456,679	[1] 457,849
III. Federal airways system and aids to air navigation					
Communication:					
Radio communication stations	17	19	29	34	45
Radio range beacon stations	0	0	2	9	33
Radio marker beacons	0	0	0	----------	6
Weather reporting airway stations—Weather Bureau and Department of Commerce, automatic telegraph typewriter equipped	----------	----------	----------	58	143
Miles of automatic telegraph-typewriter service	0	0	----------	2,415	8,400
Weather Bureau airway stations—not equipped with automatic telegraph-typewriter service	12	23	95	190	279
Weather Bureau—first-order stations (does not include airway stations)	202	207	206	207	209
Airway lighting:					
Beacons—					
Revolving and flashing listed together for first 4 years	612	760	1,188	1,311	----------
Revolving	----------	----------	----------	----------	1,290
Flashing	----------	----------	----------	----------	362
Beacons, privately owned and certified	----------	8	54	114	140
Intermediate landing fields, lighted—Department of Commerce	92	134	210	285	347
Mileage lighted by Department of Commerce	2,041	4,468	6,988	12,448	15,258
Miles under construction by Department of Commerce	1,108	1,277	2,314	1,352	3,221
IV. Airports and intermediate landing fields					
Airports:					
Commercial and private	----------	263	365	495	564
Municipal	----------	240	368	453	550
Intermediate—Department of Commerce—lighted	92	134	210	285	347
Intermediate—Department of Commerce—unlighted	0	0	0	0	7
Auxiliary—marked	----------	320	340	235	240
Army, Navy, Marine Corps, National Guard, reserve, and miscellaneous airports	----------	79	81	82	74
Total airports in operation	----------	1,036	1,364	1,550	1,782
Proposed	----------	422	921	1,413	733
Lighted, total	----------	----------	----------	----------	640
Of entry, regular	0	0	----------	10	10
Of entry, temporary	0	0	----------	8	30
V. Licenses and approvals					
Approved type certificates (issued by the Department of Commerce):					
Airplanes	0	21	96	279	390
Engines	0	4	13	35	64
Engines — foreign (temporarily approved)	0	0	6	14	14
Gliders	0	0	0	0	1

Footnotes at end of table.

TABLE 7.—*Progress of civil aeronautics in the United States, by calendar years*—Continued

	1926	1927	1928	1929	1930
V. Licenses and approvals—Continued					
Approved type certificates—Con.					
Parachutes	0	0	0	0	28
Pontoons	0	0	6	20	33
Propellers	0	0	5	135	185
Skis	0	0	0	1	14
Approvals (without approved type certificates):					
Airplanes	0	2	16	147	309
Engines	0	0	0	11	11
Gliders	0	0	0	0	1
Propellers	0	0	0	0	3
Repair stations	0	0	0	0	24
Schools	0	0	0	31	38
Unlicensed aircraft (active):					
Airplanes	----------	832	1,939	3,155	2,464
Gliders	----------	----------	----------	----------	1,012
Licensed (active):					
Airplanes	0	1,908	3,165	6,685	7,354
Gliders	0	0	0	0	76
Instructors, flying	0	0	0	111	186
Instructors, ground	0	0	0	154	263
Mechanics	0	0	0	7,624	8,993
Pilots, airplane	0	1,572	4,887	10,215	15,280
Pilots, glider	0	0	0	0	178
Riggers, parachute	0	0	0	0	86
Permits (student pilot) issued:					
Airplane	0	545	9,717	20,400	18,528
Glider	0	0	0	0	772
VI. Production and exports of aircraft					
Exports:					
Airplanes	50	63	162	354	321
Airplanes, value	$303,149	$848,568	$1,759,653	$5,574,484	$4,819,669
Engines	297	84	179	321	377
Engines, value	$573,732	$484,875	$664,826	$1,375,697	$1,635,076
Parts, value	$150,329	$570,117	$1,240,244	$2,252,203	$2,351,651
Production:					
Airplanes	1,186	1,995	4,346	6,111	3,437
Airplanes, value	$8,871,027	$14,504,999	$43,411,812	$66,638,299	$34,545,728
Engines	842	----------	3,496	[16]	4,356
Engines, value	$4,080,571	$4,783,748	$19,915,624	[16]	$22,396,054
Equipment (miscellaneous), value	$829,527	$1,873,106	$1,336,055	----------	$3,904,395
Total value all airplanes, parts, and equipment	$17,694,905	$21,161,853	$64,662,491	[12]$100,000,000	$60,846,177
VII. Other					
Legislation (aeronautical):					
States having miscellaneous laws	3	3	3	1	[16]
States having no laws	29	22	17	8	[16]
States having regulatory laws	7	13	18	20	[16]
States having uniform laws only	9	10	10	19	[16]
Firms engaged in the industry	[1] 600	[1] 900	[1] 1,400	[1] 1,500	[1] 1,500

[1] Based on reports.
[2] Reports from 51 out of 57 operators.
[3] Includes Post Office Department operations.
[4] The 1927 figures should not be used for comparative purposes as the accident reports for that period were incomplete due to the fact that the inspection service was in the formative stage with a shortage of trained field personnel to carry on the work. For the same reason there were doubtless some unreported accidents in 1928.
[5] Reports from 33 of 35 operators.
[6] Reports from 27 to 33 of 35 operators.
[7] San Francisco–Chicago operated by post office until June 30, 1927; Chicago–New York, by post office until Aug. 31, 1927. All subsequent mail carried by contract.
[8] Average base pay of pilots $189 per month, with an average of 5 cents additional per mile flown during the day and an average of 10 cents additional per mile flown during the night.
[9] Reports from 21 of 35 operators.
[10] Reports from 24 out of 38 operators for first 6 months and 47 out of 52 for second 6 months.
[11] Reports from 45 out of 50 operators for first 6 months and 51 out of 57 for second 6 months.
[12] Mail income only. No data on passenger and express.
[13] Includes mail, also passenger and express revenues from all but 5 operators.
[14] Reports from 29 out of 38 operators for first 6 months and 47 out of 52 for second 6 months.
[15] The department did not request passenger data for the years 1927 and 1928.
[16] Complete data not available at this date.

INSPECTION OF PASSENGER AIR LINES

The Aeronautics Branch continued the development of its inspection procedure under the regulations governing the scheduled operation of interstate passenger air services, which were adopted last year. Every line now engaged in carrying passengers in interstate commerce on schedule is operating under a letter of authority which is tantamount to the certificate of authority provided for in the regulations.

The inspections conducted by a staff of specially qualified air-line inspectors are producing results which may be described as threefold:

1. They give the air-line managements the benefit of outside expert advice and suggestions based on personal experience of the inspectors with the lines in question.

2. They give the Department of Commerce evidence as to the qualifications of the air lines to carry passengers in scheduled interstate commerce for hire.

3. They serve to reassure the public that the Department of Commerce and the air-line operators are cooperating closely for the further advancement of safety and reliability in scheduled air passenger transportation.

The air-line regulations have become necessary in order to standardize the various methods of scheduled interstate passenger air transport operation that have developed and will continue to develop in the future. They are in furtherance of a comprehensive, fundamental program which has been developed under the provisions of the air commerce act. Airways are now extensively established, satisfactory communications equipment is becoming available, and the required use of such facilities and aids to air navigation in the interest of increasingly safe and reliable operation in a uniform manner is definitely in order.

PROGRESS OF SCHEDULED AIR TRANSPORT

Progress of a most gratifying character has been made by scheduled air transport operations during the past fiscal year. Compared with June 30, 1930, the total mileage flown daily by air transport companies both in the United States and on foreign extensions at the end of this fiscal year showed an increase of 37,132. The present total mileage flown on schedule every 24 hours in the United States, and to Canada, the West Indies, and Latin America is 140,314. During the calendar year 1930, a total of 417,505 passengers were carried and nearly 37,000,000 miles were flown.

A general improvement in the miles flown per accident in scheduled operations is noted through the first half of the fiscal year. Reports for the last half are not yet available.

TABLE 8.—*Miles flown per accident in scheduled air transport operations*

	January–June, 1928	July–December, 1928	January–June, 1929	July–December, 1929	January–June, 1930	July–December, 1930
Miles flown	4,484,612	6,188,838	9,201,338	15,940,161	16,902,728	20,042,475
Total number of accidents	35	51	61	76	44	47
Miles flown per accident	128,132	121,350	150,842	209,739	384,152	426,436
Fatal accidents	5	7	9	15	6	3
Miles flown per fatal accident	896,922	884,120	1,022,371	1,062,677	2,817,121	6,680,825
Total pilot fatalities	4	5	9	13	5	3
Miles flown per pilot fatality	1,121,153	1,237,768	1,022,371	1,226,166	3,380,545	6,680,825
Total passenger fatalities	3	10	9	9	22	2
Passenger-miles flown	(1)	(1)	(1)	(1)	52,264,616	51,482,633
Passenger-miles flown per passenger fatality	(1)	(1)	(1)	(1)	2,375,664	25,741,316

[1] Passenger-mile figure not available for this period.

The bulk of the Nation's flying is carried on in miscellaneous operations such as student instruction, aerial sight-seeing, exhibition flying, crop dusting, aerial photography, and kindred activities. More than 108,000,000 miles were flown and nearly 3,000,000 persons were carried in this type of activity in the calendar year 1930. Of this number, about 1,850,000 were carried for hire.

For the first half of the fiscal year more than 50,000 miles were flown in miscellaneous operations for each accident, and 353,141 miles for each fatal accident.

TABLE 9.—*Mileage flown per accident in miscellaneous flying operations* [1]

	January–June, 1928	July–December, 1928	January–June, 1929	July–December, 1929	January–June, 1930	July–December, 1930
Miles flown	12,000,000	48,000,000	47,000,000	63,000,000	51,767,200	56,502,560
Total number of accidents	395	641	713	873	917	1,116
Miles flown per accident	30,380	74,883	65,919	72,165	56,453	50,630
Total number of fatal accidents	92	123	118	169	141	160
Miles flown per fatal accident	130,435	390,244	398,305	372,781	367,143	353,141
Total number of pilot fatalities	65	87	78	127	114	130
Miles flown per pilot fatality	184,615	551,724	602,564	496,063	454,098	434,635
Total number of passenger fatalities	90	120	107	134	109	104
Miles flown per passenger fatality	133,333	400,000	439,252	470,149	474,928	543,294
Total number of all fatalities [2]	155	207	185	271	238	258
Miles flown per fatality [2]	77,419	231,884	254,054	232,472	217,509	219,002

[1] Weather conditions during the last 6 months of the calendar year usually are more favorable for flying than during the first 6 months, hence, in making comparisons, figures for corresponding periods should be used in each case.

[2] Includes fatalities to pilots, copilots, students, passengers, aircraft crew, ground personnel, and spectators.

MANUFACTURING ACTIVITIES

The manufacturing phase of the aeronautics industry has changed from a large number of producing units, many of them small local companies hastily formed to supply a demand for aircraft which seemed apparent a few years ago, to a specialized group surrounded by the highest type of engineering, producing, and marketing personnel obtainable to-day.

Although smaller in number, the manufacturers now producing are better equipped to operate at high capacity than ever before. The factories possess the latest equipment and are operating according to the most efficient production methods, and could doubtless increase their production by a large amount within the next year if the need arose.

Reports showing the amount and type of production of aircraft are compiled according to calendar years. During 1930, aircraft, engines, parts, and equipment were manufactured having a total value of $61,211,198. Heavier-than-air aircraft, excluding power plants, were responsible for $27,333,736 of this total, representing 3,437 airplanes. Lighter-than-air aircraft accounted for $365,021. Airplane parts manufactured during the year were valued at over $7,000,000. The total value of aircraft engines and parts was $22,396,054. In 1929, 6,111 airplanes valued at $66,638,299 were manufactured. The total value of airplanes, parts, and equipment (not including lighter-than-air aircraft) was approximately $100,000,000 for 1929.

TABLE 10.—*Number and value of aircraft, aircraft engines, and aircraft equipment manufactured during the calendar year 1930*

AIRCRAFT

Type	Monoplanes		Biplanes		Total	
	Number	Value [1]	Number	Value [1]	Number	Value [1]
Heavier-than-air (excluding power plants)						
Open cockpit one, two, three, etc., place	280	$945,982	1,971	$13,368,461	2,251	$14,314,443
Cabin, single engine:						
One to three place	136	367,271			136	367,271
Four or more place	444	3,067,766	20	279,486	464	3,347,252
Cabin, multiengined	60	2,046,325	21	1,109,619	81	3,155,944
Amphibians	25	386,231	85	1,734,898	110	2,121,129
Seaplanes, all types	17	935,050	62	2,498,247	79	3,433,297
Autogiros	2	23,400			2	23,400
Miscellaneous [2]	114	171,000	200	400,000	314	571,000
Total	1,078	7,943,025	2,359	19,390,711	3,437	27,333,736
Parts, airplane						7,211,992
Total value of heavier-than-air aircraft and parts						34,545,728
Lighter-than-air (excluding power plants)						
Airships					2	74,604
Balloons:						
Captive					6	31,560
Free					3	12,355
Total					11	118,519
Parts, airship and balloon						246,502
Total value of lighter-than-air aircraft and parts						365,021

[1] Includes value of aircraft with instruments and accessories but does not include power plant.
[2] Includes planes and estimated value of planes constructed by individuals or concerns (not considered as aircraft manufacturers) for their own or experimental use and those manufactured by aircraft companies failing to send in production reports due to discontinuance of operations.

TABLE 10.—*Number and value of aircraft engines, and aircraft equipment manufactured during the calendar year 1930*—Continued

ENGINES

	Radial		All other types		Total	
	Number	Value	Number	Value	Number	Value
Engines (aircraft only):						
100 horsepower or less	490	$385,295	283	$250,250	773	$635,545
101 to 200 horsepower	703	1,432,325	35	63,800	738	1,496,125
201 to 400 horsepower	647	2,159,705	2	(3)	649	2,159,705
Over 400 horsepower	1,836	10,166,922	360	2,809,496	2,196	12,976,418
Total	3,676	14,144,247	680	3,123,546	4,356	17,267,793
Parts, engine						5,128,261
Total value of engines and parts						22,396,054

EQUIPMENT

	Number	Value
Pontoons (sets)	236	$1,029,060
Propellers	8,032	1,808,462
Parachutes	3,818	1,066,872
Total value of equipment		3,904,395
Grand total, aircraft, engines, parts, and equipment		61,211,198

[3] Manufactured for experimental purposes. No value given.

LICENSES AND APPROVALS

Another indication of the progress in civil aeronautics may be gleaned from the licenses and approvals issued by the Aeronautics Branch following examinations and inspections. A tabulation on this subject follows:

TABLE 11

	June 30, 1930	June 30, 1931
Licensed airplanes	6,684	7,386
Unlicensed airplanes	3,089	[1] 2,800
Licensed pilots	13,041	16,089
Licensed mechanics	8,843	9,226
Aircraft holding approved type certificates	334	426
Engines with approved type certificates	54	72
Propellers with approved type certificates	174	297
Aircraft with Group 2 approvals (approved for license but without A.T.C.)	230	358

[1] The decrease in unlicensed aircraft is regarded as a progressive step toward the elimination eventually of all unlicensed aircraft from operations.

Airports and landing fields also increased in number. At the end of the fiscal year there were 1,870 such facilities, representing an increase of 215 over the number on record a year before. The present total includes municipal and commercial airports; Army airdromes, naval and Coast Guard air stations; and Department of Commerce intermediate landing fields and marked auxiliary fields. There were 541 proposed airports of which the Aeronautics Branch had knowledge at the end of the year.

With the passing of each 12-month period, direct evidence continues to point to the permanent position occupied by aeronautics in our national economic life. Millions of people now are availing themselves of the advantages of air transportation, both scheduled and miscellaneous in character, and the value of this rapid and direct-route service doubtless has manifested itself to all who have employed it in furtherance of their business and social lives.

Before the Federal Government came to the assistance of the science and industry in 1926, the future of civil and commercial aeronautics was regarded almost wholly from a theoretical viewpoint. In the few short years that have intervened aeronautics in the United States has established an enviable record. Its world leadership in the number of pilots and planes engaged in civilian pursuits, the number of scheduled air lines, miles flown, passengers carried, pounds of mail and express transported is undisputed. The constant development that is taking place throughout the United States and the further coordination of air transportation with the best features of surface transportation all are contributing to the advancement of our Nation.

The Aeronautics Branch is proud to have a part in this pageant of historical events that is being unfolded daily and is mindful of its obligations under the air commerce act to promote and regulate civil and commercial aeronautics. To regulate is to take steps in the interest of safety. To increase the safety of air transportation is to advance and promote its use. The two are interchangeable and can not be separated without jeopardizing the future of aeronautics.

Very truly yours,

CLARENCE M. YOUNG,
Assistant Secretary of Commerce.

RADIO DIVISION

DEPARTMENT OF COMMERCE,
RADIO DIVISION,
Washington, July 1, 1931.

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 that period.

LEGISLATION

The Seventy-first Congress, third session, did not enact any radio legislation respecting the duties of the Radio Division. The only piece of special legislation concerning this division was the act authorizing the increased expense for Grand Island, Nebr., where the constant frequency monitoring station is situated. Another bill, S. 5503, was introduced to enlarge this activity by purchasing additional land, erecting additional antennas, and putting up an administration building. This bill did not pass the House of Representatives.

RADIO INSPECTION SERVICE

Inspections of the radio installations on ships are made to determine that the apparatus is in good working order and in charge of competent operators. It has for its purpose, of course, the protection of life and property.

As the law now reads, it applies to steamers only. It has been found in connection with this inspection work that there are a number of vessels propelled by Diesel engines which do not properly come under the classification of steamers, and as these vessels frequently carry 50 or more persons, the law should be amended to include this type of vessel. Such amendment could be accomplished by the substitution of the word "vessel" for the word "steamer" where it appears in the first and second sections of the act of June 24, 1910, as amended July 23, 1912.

Other inspections of the radio installations on ships and the inspection of radio stations on land are performed under authority of the radio act of 1927. Such inspections are in the nature of a general survey of the stations for the purpose of determining if the station inspected complies in every respect with the information furnished by the owner of the station in his application for a radio station license. The inspection includes verification as to the power used by the station, the wave lengths, or frequencies, to which the station may be adjusted, type of apparatus, location of station, and numerous other details.

The radio stations to be inspected are situated in all parts of the United States, Alaska, Hawaii, and Porto Rico. It is not possible with the limited inspection force of the Radio Division to inspect regularly the more than 26,000 licensed radio transmitting stations.

Those in Alaska have never been inspected, those in Hawaii and Porto Rico only on rare occasions, and a large number in the United States, principally those used by amateurs, have not been inspected. With a larger force of inspectors, a considerable number of unlicensed stations would be discovered and required to obtain a license or cease operation.

An increase is shown in all inspection duties during the past fiscal year. In the fiscal year 1930 there were 15,595 clearances of foreign and American vessels required by law to be fitted with radio apparatus and 11,334 inspections. For the fiscal year 1931 there were 15,408 clearances and 11,433 inspections. During the year 1930 there were 17,795 inspections made of all classes of stations, including ships. The number of such inspections increased to 19,458 for 1931.

Inspections during the year 1931 developed 315 defects in the radio installations on ships, which were remedied before the vessels departed. During the previous year there were 382 such defects reported. It is believed that the reduced number of defects reported for the latter period is due to the improvement in radio apparatus installed and the careful attention which has been given to radio apparatus when these inspections were made, which encourages radio operators and others concerned in keeping their apparatus in good working order.

Much of the work performed by the inspection force requires travel, either by train or by radio test cars, because of radio stations being located in practically every city of importance in the United States and many of them in rural sections. During the year 1930, 1,577 inspection trips were made and 534 cities visited, while in 1931, 1,135 inspection trips were made and 501 cities visited.

One trip was made to Porto Rico by the division's representative at Atlanta, Porto Rico being a part of the fourth radio district. This was the second inspection trip made to Porto Rico since the radio law has been in effect. The previous trip was made in 1913.

During the coming summer it is planned to have the supervisor of radio at San Francisco make a trip to Hawaii, which has not been visited for several years. Because of numerous difficulties, such as transportation, shortage of personnel, and lack of funds, it has not been possible to make an inspection trip to Alaska.

Under the radio act of 1927 all the licensed radio stations must be operated by licensed radio operators. The applicants for such licenses are given a comprehensive examination to determine their fitness. The qualifications required depend on the class of station to be operated and the class of licensed operator such station must employ. Operators for employment on ships and those on land making use of the International Telegraph Code must pass a code examination as well as a written examination, designed to develop the applicant's knowledge of the apparatus he intends to use, how to repair such apparatus or keep it in proper working order, knowledge of the national and international laws in so far as they apply to his duties, and knowledge of operating procedure intended to prevent interference and to insure orderly operation of stations.

There are 10 classes of licenses. During the early years of radio there were only 3 classes of licenses—commercial first class, commercial second class, and amateur. Additional classes have become necessary because of the development of new radio services such as broadcasting, police radio, aviation, and radiotelephone.

During the year examinations were given to 11,850 applicants for radio operators' licenses. Of this number 5,776 were for commercial licenses and 6,073 for amateur licenses. Last year there were 5,363 applicants for commercial licenses and 3,993 for amateur licenses, making a total of 9,356.

Licenses were issued to 20,703 radio operators during the year, of which there were 5,506 commercial and 15,197 amateur. The previous year's figures are 5,255 commercial and 11,541 amateur. The foregoing figures include renewal licenses issued without reexamination.

FIELD SURVEY

During the year the traveling supervisor of radio made an inspection trip which covered five radio inspection districts, the fourth, fifth, sixth, seventh, and ninth.

The primary purpose of this trip was to coordinate the work of the several offices and to obtain direct information as to the problems encountered and the possible need for additional personnel and equipment.

The supervisor found to exist a pressing need for additional personnel and equipment by practically all of the offices he visited. This need, however, will be substantially reduced soon by reason of increased appropriations for the fiscal year 1932. His report contains a gratifying statement with reference to the good will existing between the public and the Radio Division and appreciation of its cooperative efforts and desire to be helpful in connection with the enforcement of the radio law.

RADIO TEST CARS

During the past fiscal year, two additional test cars were placed in service, one at Boston and the other at Seattle. This brings the total number of cars in service to eight. The cars delivered to Boston and Seattle are not yet equipped with field strength measuring apparatus, or mobile secondary standards of frequency, but it is contemplated that this equipment will be installed in the early fall of 1931.

With the six radio test cars, fully equipped with field strength measuring apparatus and mobile secondary standards of frequency, it has been possible during the past year, to make a large number of field strength surveys to determine the service areas of broadcast stations, and ascertain whether or not they render good broadcast service to radio listeners in their respective areas. With these cars, it has also been possible to ascertain the energy in harmonics from broadcast and other stations, with a view to the elimination of these parasitic radiations.

During the fiscal year 1932, two or more of the chassis on the radio test cars now in use should be replaced, as these cars now have been run in excess of 60,000 miles. The repair items on these cars will gradually increase with their mileage, and since they are required to travel all kinds of roads in all kinds of weather and transport the delicate precision apparatus, the cars must be kept in a high state of repair at all times.

It would not be possible, to-day, to do our field work and the monitoring of low-power radio stations without these cars. Additional cars could be used to advantage if placed in service at New York, Los Angeles, and Kansas City.

MOBILE STANDARDS ON RADIO TEST CARS

The large number of low-power broadcast and other stations which operate on shared channels in the United States cause very serious heterodyne interference, and in many cases it is impossible to measure the frequency of these stations at the regular monitoring stations. To take care of this situation, mobile standards have been placed on six of the radio test cars located at Baltimore, Atlanta, Dallas, San Francisco, Chicago, and Detroit. With this equipment, it is possible, in many cases, to reduce heterodyne interference on broadcast channels adjacent to shared channels by making sure that the low power stations are operating on their assigned frequencies.

MONITORING BROADCASTING STATIONS

Although the monitoring stations at Boston, Baltimore, Atlanta, New Orleans, Los Angeles, San Francisco, Portland, Oreg., Detroit, Chicago, and Grand Island maintain watches less than 8 hours out of the 24 during working days, these stations reported 76,447 frequency measurements during the fiscal year as compared with 45,695 for the previous year. The United States stations measured are classified as follows:

Broadcasting	469	Police	18
Commercial	142	Aeronautical land	17
Amateur	336	Ship	10
Experimental	60	Airplanes	4
Government	59		
Unidentified	23	Total	1,138

Stations were measured in 36 foreign countries. These stations are classified as follows:

Broadcasting	31	Ships	5
Commercial	125		
Amateur	27	Total	188

The records of the division show a constantly increasing improvement in frequency control since the monitoring work of the division was undertaken. As an illustration, in December 339 broadcasting stations were measured. The frequency variation of 35 of these stations was less than 100 cycles above or below the assigned frequency. The frequency variation of 66 of these stations was less than 200 cycles above or below the assigned frequency, while the frequency variation of 238 of these stations was more than 200 cycles above or below their assigned frequencies.

In June 330 stations were measured. The frequency variation of 97 of these stations was less than 50 cycles above or below their assigned frequencies. The frequency variation of 71 of these stations was less than 100 cycles above or below their assigned frequencies. The frequency variation of 69 of these stations was less than 200 cycles above or below their assigned frequencies. The frequency variation of 93 of these stations exceeded 200 cycles.

At the present time the Federal Radio Commission requires broadcasting stations operating between 550 and 1,500 kilocycles to maintain their assigned frequencies between the limits of 500 cycles per second above to 500 cycles per second below the assigned frequency.

Beginning with June 22, 1932, the tolerance of 500 cycles now permitted will be reduced to 50 cycles. The reduced tolerance will necessitate broadcasting stations exercising greater care and in some cases providing better equipment. It is anticipated that this will also mean a considerable increase in the work of the monitoring stations.

CONSTANT FREQUENCY STATION

The construction work on the large frequency monitoring station at Grand Island, Nebr., was practically finished during the fiscal year. The Diesel-engine driven generators were installed in the power house and placed in operation on December 5, 1930, and frequency measurement work was begun about the middle of February, with a small, inadequate corps of radio engineers and other personnel. During the brief time the station has been in operation, highly accurate frequency measurements are being made daily on radio stations in the United States and foreign countries. Telephone and telegraph stations in Argentine, Austria, Australia, Brazil, Belgium, Canada, Chile, Cuba, Colombia, Costa Rica, China, Czechoslovakia, Dominican Republic, England, Egypt, France, Germany, Hawaii, Holland, Indo-China, Italy, Japan, Java, Madagascar, Morocco, Mexico, Norway, New Caledonia, New Zealand, Portugal, Philippine Islands, Panama, Persia, Russia, Spain, Syria, Venezuela, and other countries are received and measured daily. At the present time, due to insufficient personnel, the station is in operation only 16 hours daily; thus, full advantage can not be taken of all the facilities at the station for making frequency measurements and other observations.

Since the station was placed in operation in February, a total of 3,029 measurements have been made. At the end of the fiscal year, 167 different radio stations located in foreign countries had been measured, a total of 789 measurements being made on these stations. It is interesting to note that a very large number of these stations failed to maintain their assigned operating frequencies, and in many cases were observed to be causing interference with radio telephone and telegraph stations operating in the United States. In addition to the foreign stations measured, 2,240 measurements were made at Grand Island on 650 individual radio telephone and telegraph stations within the continental limits of the United States.

It requires 9 skilled radio engineers to intercept and measure the signals from radio telephone and telegraph stations, each watch, at Grand Island. These watches, at the present time, are of 8 hours duration, and sufficient personnel should be provided so as to make available the required number of engineers for each watch, and to have the station in operation 24 hours each day. If this were done, it would be possible to make 2,000 or more accurate measurements per month, in addition to making other observations, such as channel congestion, material broadcast, improper use of frequency assignment, and other special tests.

The antenna systems at Grand Island are inadequate to cover the United States. Two additional broadcast antennas should be provided, one for reception of stations in southeastern United States and the other for stations in northwestern United States. In addition to these antennas for broadcast purposes only, additional antennas for high-frequency reception are needed. Two additional re-

ceivers, one for high-frequency work, the other for broadcast and other services, could be used to advantage. A high-speed recorder should be provided for the interception and identification of high speed automatic transmitting stations, and their frequencies measured. An experimental receiver for interception of television and measurement of the frequencies of television stations should be obtained as soon as possible. At the present time these stations can be measured but can not be identified.

The public has shown great interest in the station, this interest being evidenced by the fact that 2,219 persons have visited this station since March 15, 1931. They have registered from almost every State in the Union, and include Representatives from both Houses of Congress, and officials from the larger radio and telephone operating companies.

SECONDARY STANDARD MONITORING STATIONS

During the past fiscal year, nine secondary standard stations were installed and placed in operation in the following cities: Atlanta, Baltimore, Boston, Chicago, Detroit, New Orleans, Los Angeles, San Francisco, and Portland. With these secondary standards of frequency, it has been possible to measure the frequencies of many hundreds of transmitting stations in the United States and some foreign stations.

The increasing accuracy of frequency maintained by radio stations is conclusive evidence of the benefits derived by station owners and listeners since monitoring by these stations began.

MEASUREMENT OF THE QUALITY AND QUANTITY OF MODULATION

For some time tests have been carried on to determine a satisfactory method of measuring the percentage of modulation at broadcasting and other radiotelephone stations. The Radio Division now has portable and highly accurate equipment in use for the measurement of the power or field strength of radio stations and for the measurement of the frequencies of stations. To make its service complete it is necessary to measure the third characteristic of a radiotelephone station, which is its degree and quality of modulation. This characteristic is the one which definitely determines the quality of reception. The necessity for modulation measurements are, therefore, apparent.

Many experiments have been conducted by the Radio Division during the past several months on all available types of modulated radio transmitters to determine how these measurements could best be made. These experiments have gone so far as to include television.

A special instrument developed for the purpose has been used with very satisfactory results. By means of it many radio broadcasting stations have been able to make adjustments to their transmitters which very materially improved their service to the public. These adjustments could not have been made without some device of this nature and the cooperation which has been rendered in this field is a source of considerable satisfaction.

Further tests are being conducted with a view to being able not only to measure the percentage of modulation and the quality of it but

also the determination of the degree of distortion which might be present. Similar tests are also being conducted to measure these important factors at the various monitoring stations operated by this division so that it will not always be necessary to take the equipment to the station under observation to make the test.

These tests, and the development of equipment under them, have been especially significant in that they enable the broadcaster to improve his service to the public and the radio listening public to enjoy better radio reception through the reduction in distortion. Also, they show directly whether the station is meeting the requirements of the Federal Radio Commission with respect to quantity and quality of modulation.

RADIO FOR AVIATION

There has been an encouraging increase in the use of radio in the aeronautical service during the past year. The records of the division show that licenses have been issued to 99 aeronautical stations and 17 permits have been issued for construction of aeronautical stations. When these stations are constructed there will be a total of 116 such stations as compared with 66 stations and 23 outstanding construction permits last year. Last year there were 215 planes equipped with radio. There are now 303. The above figures do not include Government stations.

The ground stations are spaced along the airways so as to insure continuous communication between aircraft in flight and the station on the ground. There is an average separation between ground stations of 200 miles so that the maximum range to be covered in communication is approximately 100 miles. Experience has shown that with this fairly close spacing of transmitters reliable communication can be conducted under any but the most adverse conditions.

Radiotelephone apparatus is most generally used. The aircraft radiophone installations are extremely simple and are controlled by a single push button so that the pilot may operate the system with a minimum of effort. Trailing antennas such as necessary when longer wave lengths are used have been eliminated, making it possible for aircraft to engage in transmission while on the ground as well as in the air. The traffic handled consists of messages relating to safety, position reports, meteorological reports, arrivals and departures, and anything pertinent to the movement of aircraft.

RADIOBEACONS AND RADIOCOMPASSES

Safety of navigation has been further increased through the installation of additional radiobeacons and radiocompasses. There are 90 radiobeacons in use in the United States at the present time, an increase of 10 over the preceding year.

The radiocompass is recognized as one of the most useful aids to navigation in use on vessels. Its value in locating vessels in distress has been demonstrated frequently. On vessels of the United States there are 1,334 radiocompasses installed, an increase of 66 during the last fiscal year.

Reports from many of the air-mail operators indicate improvement in their performance schedules through the use of these radio aids to navigation.

An observer of foreign aeronautical radio services expresses the conviction that our system of Government and private aids to air navigation are unequaled in the balance of the world.

AUTOMATIC ALARM SIGNAL DEVICE

Inspection of automatic alarm devices was continued during the past fiscal year. In this period 871 inspections were made of these instruments, used exclusively on foreign vessels. According to reports made to the division by its inspectors these devices responded 1,244 times to signals not intended to actuate the apparatus. Last year there were 755 inspections and 1,210 false alarms, usually reported as caused by heavy static or the operation of near-by transmitters. The consensus of opinion seems to be that the alarms now used are possibly of greater value than the untrained watcher, but provides a poor substitute for a trained licensed radio operator. The division is preparing to observe tests of two such devices manufactured in this country which are to be installed on vessels on the Great Lakes during the coming summer.

POLICE RADIO

The use of radio as an aid in directing the work of police continues to grow. Last year there were 20 radio transmitting stations used by police departments, while this year there are 53 such stations licensed and in operation and construction permits have been issued for 10 more.

According to a report made by the chief of police in an important western city, during one month of the fiscal year just closed 80 stolen automobiles were recovered and arrests were made in connection therewith, 9 persons were arrested charged with robbery, etc., 11 persons were arrested for violations of the traffic laws, and 1 person was arrested charged with intent to commit murder. This police chief states: "This is a remarkable showing when one realizes that the results were obtained solely through the radio broadcasting available to this department up to 11 p. m. daily, after which hour we have no such service." The city referred to above now has a radio broadcasting station of its own which can be used 24 hours each day.

AMATEURS

The past fiscal year shows increasing interest on the part of amateurs. In 1929 there were 16,829 licensed amateur radio stations, in 1930 there were 18,994, and this year there are 22,739. These figures indicate that the amateurs are by far the largest users of transmitting radio stations in the United States. In addition to the licenses issued to the amateur stations, correspondence with the Radio Division shows that there are more young men making inquiry with reference to obtaining such licenses than in any previous year. It is believed that this growing interest may be attributed to the use of the radiotelephone by amateurs.

The amateurs have given much attention to attaining frequency precision and control of their apparatus. The standard frequency

system sponsored by the American Radio Relay League, and inaugurated last year on a nation-wide basis, has been continued during the fiscal year just ended. As high as 300 calibrations a month have been reported from this service. The benefits derived from these standard transmissions sent by the amateurs themselves are not confined to the amateurs in this country. It is reported that many foreign amateurs, particularly those in South Africa and Australia, have been utilizing these transmissions on the higher frequencies.

With such a service regularly available, considerable interest has been evinced in the popularization of measuring equipment of a standard comparable in accuracy and stability to the transmissions, and yet within the financial and constructional abilities of the average amateur. The American Radio Relay League reports that their laboratory work has resulted in the development of dynatron oscillator equipment which fulfills these specifications, affording tolerances well within 0.01 per cent and still easily constructed and calibrated. With such equipment available, together with the transmissions supplied by the standard frequency stations, large numbers of amateurs have built and now possess measuring apparatus equal to that in many laboratories. The good effects have been apparent. In line with their long established self-policing policy, the amateurs have created a system of official observing stations, the amateur stations so appointed being equipped with reasonably accurate measuring apparatus for regularly observing and reporting any off-frequency violators among the amateur ranks. The American Radio Relay League reports that approximately 100 appointments have been made.

The communications possibilities of frequencies on the order of 56,000 kilocycles have been examined and considerable development work accomplished in the design of radiotelephone transmitters and special receivers of the superregenerative type to work on these frequencies.

While no major emergency occurred in the United States to enable the amateurs to participate in the storm relief work for which they have been noted in recent years, greater cooperation has been afforded to more than a dozen expeditions sailing from the United States, and increased activity is reported in connection with the Naval Radio Reserve and the Army Amateur Radio System.

The monitoring stations of the division are regularly engaged in measuring the frequencies of amateur stations. Comparatively few violations have been found and only a few have been penalized for such violations. It seems evident that the amateurs realize that their future success and public good will depend upon the operation of their stations in an orderly manner, having due regard for other users including the broadcast listeners. When a new amateur enters the field his transmissions are usually observed by the older amateurs who take such action as may be necessary to bring him in line with the self-policing policy of the organization.

INTERNATIONAL CONFERENCES

The first meeting of the International Technical Consultative Committee on Radio Communications for the purpose of studying technical and related questions was held at The Hague, Netherlands, in

September, 1929. The second meeting of this committee was held at Copenhagen, Denmark, May 27 to June 8, 1931. Representatives of the government departments interested in the subjects to be considered and representatives of commercial companies attended this meeting. The next meeting which is to be held in 1933 will be at Lisbon, Portugal. The date of holding this meeting has not been announced.

The United States proposals for consideration at the International Radio Telegraph Conference to be held in Madrid, Spain, in September, 1932, have been submitted to the International Radio Telegraph Bureau, Berne, Switzerland, for distribution to members of the union. The exact date of holding the conference in Madrid has not been announced.

In view of the fact that this conference will be a joint conference of members of the International Telegraph Convention and the International Radio Telegraph Convention and the importance of some of the problems to be considered, it seems probable that the duration of the conference will be longer than those held heretofore.

INTERNATIONAL RADIO ACCOUNTING

Activities of the international radio accounting section during the fiscal year just ended may be summarized as follows:

Number of accounts handled:	
On hand July 1, 1930	569
Received during year	1,099
Total	1,668
Settled and cleared	1,237
Accounts on hand and unsettled June 30, 1931	431
Financial operations required to complete activities summarized:	
Cash balance July 1, 1930	$40,950.83
Collections during fiscal year of 1931	65,591.46
Total	106,542.29
Disbursements during fiscal year of 1931	80,572.11
Cash balance, July 1, 1931	25,970.18

It is apparent from these figures that the number of accounts received from foreign administrations has increased over last year's receipts. This increase was taken care of in the number of accounts settled and cleared. The number of accounts remaining on hand at the end of last fiscal year was also reduced by 138 accounts.

In spite of the increased volume in number of accounts received and cleared, there has been a reduction in the money transaction which would indicate that the volume of radiotelegrams exchanged by American vessels and foreign coastal and ship stations was less in 1931 than in 1930.

The decrease in the cash balance of the year indicates only that the 431 accounts remaining on hand and unsettled involve a proportionately lower amount of partially collected tolls.

Very truly yours,

W. D. TERRELL,
Director of Radio.

BUREAU OF THE CENSUS

DEPARTMENT OF COMMERCE,
BUREAU OF THE CENSUS,
Washington, July 1, 1931.

The honorable the SECRETARY OF COMMERCE.

DEAR MR. SECRETARY: I submit the following report of the work of the Bureau of the Census during the fiscal year ended June 30, 1931.

INTRODUCTION

It is indeed gratifying to report that the close of the fiscal year 1931 finds a major part of the Fifteenth Decennial Census tabulation work completed and final or preliminary reports issued on practically all the subjects covered. The field work of the census was finished and the tabulation of returns started soon after the opening of the year.

Population figures for the United States, by States, excluding Indians not taxed, and the congressional representatives to which each State would be entitled (under both the major fractions and the equal proportions methods of apportioning membership to the House of Representatives) were furnished to the Secretary of Commerce on November 17, 1930, for transmission to the President, and were forwarded by the President to Congress on December 4, 1930, in accordance with the terms of the Fifteenth Census act. Each Senator and Representative in Congress was also furnished a tabulation showing the population in his respective State and district.

The policy of issuing press releases presenting results as rapidly as the tabulations could be made for the various units, and of combining unit reports and republishing promptly data for larger units, has been continued in the current census. Through this procedure census information has been made available to the public in a remarkably short time after receipt of schedules in the bureau. The efficacy of the plan was proved by the enthusiasm with which census information was received by the press and the public generally. There was also a very gratifying demand for all the releases—so great a demand, in fact, as to necessitate the issuing of second and even third editions of many of them. The preliminary reports of the new census of distribution and the preliminary industry reports of the census of manufactures have also proved of special interest as important indices to industrial conditions during the present business depression; while the unemployment statistics have been exceedingly timely and useful.

Volume I of population.—Volume I of the Fifteenth Census Reports—Number and Distribution of Inhabitants—was printed and distributed just 13 months after the canvass started (April 2, 1930),

as compared with 20 months required for the publication of a similar volume at the census of 1920. This octavo volume of 1,268 pages, contains population statistics for all States, Territories, and outlying possessions, by minor civil divisions, together with a United States summary showing the distribution of the population by States, counties, and principal cities by size groups.

Another record was established by the division of manufactures, which completed the publication of its preliminary industry reports within the calendar year 1930. At previous censuses the issuance of these preliminary industry reports had never been completed until April or May of the year following that in which the canvass was made.

Publication dates have been advanced on all phases of the census work, in spite of the fact that the number of inquiries on the various schedules were generally increased, and that the censuses of distribution and unemployment were added. This advancement in the dates of publication is attributable to two factors: Improvement in the methods of conducting the census and improvement in the machinery and equipment used to tabulate the returns.

More than 50 per cent of the individual State population and agriculture reports have already been printed and distributed. These reports were included in the following series: Number and Distribution of Inhabitants, Composition and Characteristics of the Population, Unemployment, and Agriculture—three series, one presenting information by minor civil divisions, and two by counties.

The distribution division has also finished its series of printed press releases giving retail-trade data for all towns of 10,000 population or more, and wholesale-trade data for cities of 100,000 or more, and has started the issuance of State and merchandise reports. The division of manufactures has likewise completed its preliminary summaries for industries and States and has started issuing printed industry reports.

Final volumes.—These State and industry reports will be assembled and supplemented by summary tables and analytical text to form volumes of the final reports. The titles of the proposed volumes of the Fifteenth Decennial Census report are:

POPULATION

Number and distribution of inhabitants—Population of States, counties, cities, and minor civil divisions. (First series of State bulletins.)
General report and analysis—Population by color, race, sex, age, marital condition, etc.
Composition and characteristics of population—Second series of State bulletins:
Part 1. United States summary and Alabama to Missouri.
Part 2. Montana to Wyoming.
Occupations—State bulletins—General tables and analysis.
Economic and natural families—Dwellings and families, ownership of homes, etc.
Unemployment—Number unemployed at date of census for United States, States, and principal cities.

AGRICULTURE

Farm acreage and farm values, by townships or other minor civil divisions.
Reports for States, with statistics for counties and a summary for the United States and the North, South, and West:
Part 1. The Northern States.
Part 2. The Southern States.
Part 3. The Western States.

Statistics by type of farm, with statistics for counties and a summary for the United States and the North, South, and West:
Part 1. The Northern States.
Part 2. The Southern States.
Part 3. The Western States.
Special reports (brief studies on agricultural subjects: Horticulture, etc.).
General report and analytical tables.
Irrigation of agricultural lands (one volume).
Drainage of agricultural lands (one volume).

MANUFACTURES

General report and analysis—United States, by industries and States.
Reports for industries—General statistics, by States; quantities and values of products in detail.
Reports for States—General statistics, by industries, for States, industrial areas, and important counties.

MINES AND QUARRIES

General report and analysis—United States, by industries and States.

DISTRIBUTION

Reports for States (retail and wholesale)—States, cities, and counties.
Special trade reports.
Hotel reports—States and principal cities.
Construction industry—States and principal cities.

In addition to volumes of the final report, several special monographs and studies are to be prepared from census information and published by the bureau as a part of the Fifteenth Decennial Census work.

Other activities.—Concurrently with the Fifteenth Decennial Census work, the bureau has been carrying on its regular activities without abatement.

The scope of the current industrial inquiries has been extended and the reports improved. Seven new industries have been added to the list of industries covered, making a total of 51 inquiries which are answered by 5,110 manufacturing establishments, and by approximately 7,900 dealers in certain classes of merchandise. The reports have been materially improved by the inclusion of graphs showing at a glance the trend of industrial activities reported. Of these 51 reports published, 43 are released monthly, 7 quarterly, and 1 weekly. The statistics for each inquiry relate generally to one or more of the following: Production, new orders or bookings, sales, shipments, unfilled orders, cancellations, stocks, financing (automobile), and space operated and occupied in public merchandise warehousing.

During the year South Dakota was added to the registration area for deaths, which area now includes 96.2 per cent of the total population of the United States and its possessions. The birth-registration area covers about 95 per cent of the total population.

Statistics of marriage and divorce continue to be received with much interest and given close study by interested agencies. This information is issued in preliminary summaries for States as rapidly as the information is received, and is finally assembled in annual reports. Annual statistics are likewise gathered and published on institutions, State and city governments, and certain special industries. All of these inquiries have been continued during the fiscal year, despite the unprecedented amount of work resulting from the Fifteenth Decennial Census, which undoubtedly is the most compre-

hensive statistical survey ever undertaken by this or any other Nation.

Bureau personnel.—There were on the rolls of the Bureau of the Census employed in Washington on July 1, 1930, a total of 5,032 persons, of whom 713 were permanent employees. In addition, there were employed in the field a total of 6,472 employees, of whom 726 were special agents appointed to collect data for the cotton reports. The remaining 5,746 field employees were practically all engaged in the collection of the Fifteenth Decennial Census data.

On July 1, 1931, there were employed in the Bureau of the Census at Washington a total of 5,811 employees, of whom 680 held permanent appointments. Of this force, 89.8 per cent were engaged on Fifteenth Decennial Census work. In addition, there were employed in the field a total of 1,028 persons, of whom 747 were special agents assigned to the collection of data for the cotton reports, and 87 were engaged in the preparation of financial statistics reports for States and cities.

The problem of carrying on the regular intercensal investigations during the decennial census period was solved in some degree during the last fiscal year by the assignment of temporary employees to do the work normally done by the trained permanent personnel, the largest part of whom are engaged on decennial census work in supervisory capacities.

New divisions.—In order to centralize and systematize the gigantic tasks of recording and tabulating census information and distributing the press announcements and reports, three new divisions were created under the following titles: Punching, tabulating, and publications. The wisdom of this action has been proved by the increased efficiency which has resulted. Heretofore, all the work now concentrated in these new divisions was handled by the respective division of inquiry concerned. Worthy of special note is the elimination of wastage through duplications and wrong addresses resultant from the revision of the mailing lists for press announcements and reports.

Metropolitan districts.—The population of a city often gives a very inadequate idea of the population massed in and around that city, constituting the "greater" city, as it is sometimes called; and in few cases do the boundaries of the city limit the urban population which that city represents or of which it is the center. In view of this situation the Bureau of the Census has established metropolitan districts to include in a single total both the population of the central city itself and that of the suburbs or urbanized areas surrounding it, the rule being to include all adjacent areas having more than 150 inhabitants per square mile. A district was established for every city where the population of the city itself plus that of the included territory amounted to 100,000 or more. The results have been published in a bulletin giving the population in detail and a map of each district.

PUNCHING AND TABULATION OF RETURNS

Prior to the census of 1930 the punching of cards, or the mechanical recording of information, was conducted in the various divisions of the bureau. For example, the population division had charge of the punching and tabulation of cards, along with the work of coding and

filing population schedules, and the publication of results; the division of manufactures likewise had charge of all the work in connection with the census of manufactures, etc.

At the beginning of the census for 1930, it was decided to concentrate all punching and machine tabulation work into the two separate divisions of punching and tabulation. The improved results have justified the concentration.

Punching division.—The punching force has been mobile, thus making it possible to interchange the work of the different divisions among the operators without loss of time. The modified key punch and schedule holder also added efficiency and speed to the punching work. When the work was at its peak, an average of 1,791 individual population cards were punched per day per operator for the month, as compared with 864 individual population cards punched per day per operator on the old pantagraph punch in 1920.

During the process of the Fifteenth Census, cards have been punched for 20 separate inquiries, involving a total of approximately 290,000,000 cards. The distribution of these cards is shown in the following tabulation:

Investigations	Cards punched
Population:	
Continental United States	124,952,063
Alaska, Hawaii, Porto Rico, Guam, Samoa, Panama Canal, and Virgin Islands	2,147,460
Voters in District of Columbia	15,106
Census of unemployment—preliminary	15,843
Census of unemployment, 1930	4,056,435
Census of unemployment, 1931—Selected cities	2,361,712
Blind and deaf-mutes	123,903
Family—New Haven, Conn	73,994
Family—Continental United States	5,444,941
Divorce, 1929	203,743
Prisoners, 1928	93,037
General farm:	
Continental United States	[1] 140,501,216
Hawaii and Porto Rico	680,323
Incidental agricultural production	434,194
Irrigation	274,078
Drainage	355,081
Distribution:	
Preliminary	1,709,006
Retail	1,797,765
Wholesale	979,469
Construction	120,891
Hotels	15,567
Current inquiries (quarterly):	
Radio goods	75,886
Electrical appliances	69,446
Manufactures	1,044,667
Mines and quarries	48,315
Profits study	346,130
Village population, 1930 (committee on social trends)	134,673
Total	289,562,525

All cards punched have been verified, except about one-fourth of the cards for the manufactures and mines and quarries schedules, and more than 575,000,000 cards have been handled in this division since its organization March 16, 1930.

[1] Includes 7,454,291 cards handled the second time for punching the type of farm and value of products codes.

At the peak of the punching work, the personnel of this division numbered about 2,000, which was the largest force ever assembled in one organization for the punching of cards; likewise the equipment used included more punching and verifying machines than had ever been installed in one bureau or organization.

Tabulation division.—The concentration of the machine tabulation under one official has proved equally as satisfactory as in the case of punching. It has been possible to do machine tabulation for several phases of census work at the same time, which has resulted in a more prompt publication of results. The sorting and tabulating equipment in use at the present census has reached a high stage of efficiency, and part of it was perfected in our mechanical laboratory.

The following statement shows the numbers of punched cards handled in the machine tabulation division during the past fiscal year on the five general sections of the work, representing the equivalent of passing cards through the machine one time in each case:

Section of work:	Number of cards
Population	1,634,051,872
Agriculture	723,136,055
Manufactures	18,703,620
Distribution	30,857,364
Miscellaneous (including current inquiries)	120,876,494
Total	2,527,625,405

Publications division.—The publications division was organized to meet the need for a centralization of the publication and distribution of census information. Prior to its organization, each division of inquiry handled the publication and distribution of its various reports.

The new division was created in the fall of 1930 and immediately set to work centralizing and systematizing the publication and distribution of all the material issued by the bureau. The revision of the mailing lists, and the supervision of the work in the duplicating department of the bureau, were especially noteworthy accomplishments of this division, which now handles efficiently the constant stream of releases and reports issued by the bureau.

CENSUS OF POPULATION

The examination and hand count of the population schedules started in May, 1930, was practically completed in seven months, and a press release presenting the final population figures for the United States, by States, was issued on November 22, 1930.

Preliminary statistics.—The first count of the number of names returned on the population schedules, however, was made by the supervisors in the field, and the results were announced locally by them immediately after the completion of the enumeration. The results of these counts by the supervisors subsequently were assembled and issued by the Census Bureau in a series of press releases giving the population of each State by counties with figures for the larger cities. The first of these State releases was issued on June 21, 1930, and the last on August 25, 1930. A press release giving the population of the United States by States, based on this preliminary count was issued on August 8, 1930, the preliminary total

being 122,698,190, which differed by only 76,856 from the final count of 122,775,046.

State bulletins.—The first of a series of State bulletins, showing the distribution of the population by minor civil divisions, was issued on July 31, 1930, and the last State bulletin of this series was issued December 29, 1930. The United States summary bulletin for the series was issued January 27, 1931. Similar bulletins were also published for the Territories and outlying possessions. This complete series was bound together to form Volume I of the Fifteenth Census Reports on Population, which was issued in May, 1931. This report was printed in octavo form to meet the demand for a handy volume of population figures of general interest.

General population classification.—General population schedule coding was begun in May, 1930, and was completed in December of that year. The composition and characteristics of the population for States, counties, and cities, tabulated on the basis of this coding, are presented in a second series of State bulletins, the first of which, the bulletin for Delaware, was issued in December, 1930. At the close of June of this year, 26 bulletins of this series had been issued, and bulletins for 19 additional States were in process of printing. Preliminary press releases giving the most important figures for States and the larger cities, together with a brief classification of the population for counties, had been issued for all except 4 States. These releases cover information shown in more detail in the bulletins as to color, nativity, sex, age, country of birth, illiteracy, school attendance, marital condition, and industry groups.

Subject bulletins.—The remaining material to be tabulated from the population card, aside from occupations, is being prepared for presentation in a series of subject bulletins, the topics corresponding approximately with the topics covered by the chapters in Volume II of the 1920 reports, viz, color or race, nativity, and parentage; sex distribution; age distribution; marital condition, etc. The subjects on which no data were presented in the second series of State bulletins include State of birth of the native population, age by single years, marital condition, and illiteracy by age; and for the foreign-born white, mother tongue, year of immigration, and ability to speak English.

Occupation statistics.—The results of a preliminary tabulation showing the number of gainful workers, by sex, in about 50 industry groups, were published in the second series of State bulletins. The detailed tabulation of gainful workers, classified by specific occupation as distinguished from the broad industry groups of the preliminary count, was started on March 17, 1931, and the first press release giving preliminary figures for the gainful workers classified according to occupation was issued on April 23, 1931. At the close of the fiscal year, similar releases had been issued for 4 States and 30 cities, and copy had been prepared for 3 bulletins in the series presenting these statistics by States, with figures for cities of 25,000 or over. In this series of bulletins, the gainful workers are classified not only by sex and by occupation, but also by color, nativity, and age, and the female gainful workers are also classified by marital condition.

Family data.—The census information with regard to families is being tabulated from a separate family card. The first process

in the tabulation of this information was the transcription of the family data from the population schedule to a condensed transcription sheet from which the cards could be conveniently punched. At the end of the fiscal year this transcription had been completed for 37 States, comprising nearly one-half of the families in the United States. Cards had also been punched for 23 States comprising about one-fifth of the total number required.

A part of the results of the family-card tabulation will be presented in a series of State bulletins, and the remainder in a brief series of subject bulletins. The State bulletins will present the number of families by counties, with figures for all incorporated places having 2,500 inhabitants or more, and will show the number of families classified by size, by color and nativity of head, and according to the number of children under 10 years of age in the family. In addition, there will be presented the number of dwellings, classified as one-family, two-family, and three-or-more-family dwellings; the number of owned homes, classified according to value; and the rented homes according to monthly rental. (The classification of homes by value and rental is limited to nonfarm homes.) They will also be classified according to number of children under 21, number of gainful workers, and number of lodgers. There will be a classification of home makers according to employment status, first, segregating those who have no gainful occupation, and second, separating those who have an occupation which takes them away from home into several groups, such as professional workers, office workers, and industrial workers.

Blind and deaf-mutes.—A hand count of the blind and deaf-mutes has been made from the population schedules and a report, presenting the results of this count, has been printed.

CENSUS OF UNEMPLOYMENT

The preliminary announcement of the returns of the census of unemployment for the United States, by States, was made available in August, 1930. Other releases during the summer of 1930 gave preliminary returns for counties and cities. On March 21, 1931, the final unemployment returns by classes for the United States, by States, was issued in press release form. The first State bulletin, giving final unemployment returns by classes, appeared in November. At the close of the fiscal year, 29 State bulletins had been printed and 16 more were in process of printing.

A special census of unemployment was taken in January, 1931, supplementing the data collected on this subject at the census of 1930. This census was authorized in connection with the work of the President's Emergency Committee on Employment, and the results were made available to that committee on March 21, 1931.

CENSUS OF AGRICULTURE

The first results of the census of agriculture were presented in a series of State press releases—started in August, 1930—giving the number of farms by counties as determined by a hand count of the general farm schedules. This series was followed by a preliminary announcement on October 15, 1930, of the number of farms in the

United States, the number announced being 6,297,877, only 9,229 more than the final total of 6,288,648.

State bulletins.—There will be four series of State reports issued in connection with the census of agriculture, and copy for the first two is now in the hands of the printer. More than 60 per cent of the series presenting the following information by minor civil divisions has been printed: Number of farms; acreage of land in farms, classified according to use; and value of land and buildings, buildings, farmers' dwellings, and implements and machinery. This is the first census since 1870 at which agricultural data have been published by minor civil divisions, and the first census at which the value of farmers' dwellings has ever been ascertained, although the value of all farm buildings was secured at the census of 1900 and at each succeeding census. All farm buildings in the United States were reported in 1930 as valued at $12,949,993,774, and of this amount, the value of farmers' dwellings represented $7,083,572,150, or 54.7 per cent.

County statistics.—The three additional series of State reports for agriculture will present statistics by counties. Twenty-seven reports of the first county series have been printed. They show the number, acreage, and value of farms, by color and tenure of operator; number of each of the principal classes of livestock; acreage and production of selected crops, and acreage and value of vegetables raised for sale. It has been determined that the number of horses on farms decreased from 19,767,161 in 1920 to 13,383,574 in 1930, a decrease of 6,383,587, or 32.3 per cent. The number of mules on farms decreased from 5,432,391 in 1920 to 5,353,993 in 1930, a decrease of 78,398, or 1.4 per cent.

Farm expenses, debt, taxes, etc., and types of farms.—Only the Delaware report has been printed as yet of the second and third county series of agricultural reports. The second series will give information on farm debt, taxes, expenditures, machinery, and facilities; cooperative marketing; movement of farm population; number of sheep, goats, and bees; livestock products, miscellaneous crops, value of livestock, and value of products. The third series of State reports will include information concerning farms and farm acreage, value of farms, value of farm products sold, specified classes of livestock, livestock products, tenure, and specified farm expenditures, all classified by type of farm. This is an innovation in census tabulations, although a somewhat similar classification was made in 1900. The farms are classified by types according to principal sources of income, 40 per cent of value of products governing their classification. The types of farms are as follows: Self-sufficing, truck, fruit, cash-grain, cotton, crop-specialty, general, dairy, poultry, stock-ranch, animal-specialty, abnormal, and unclassified. The abnormal type is subdivided into five subtypes: Institution or country estate; part-time; boarding and lodging; forest-product; and horse farm, feed lot, or livestock dealer.

Special farm tabulations.—At the request of the Department of Agriculture, a special tabulation of farm acreage, classified according to the use of the land, and the value of farm land and buildings for specified townships or wards in Arkansas and Louisiana, was

made in advance of the machine tabulations for these States. These data were used by the Department of Agriculture in making a valuation for the War Department of certain lands in the Lower Mississippi Valley included in the plans for flood control.

The publication of statistics of the number, acreage, and value of farms, by minor civil divisions, has brought a number of letters of appreciation, and a demand is being made for data on livestock, livestock products, crops, and other items by such divisions.

Census of horticulture.—The horticultural census was taken by mail subsequent to the decennial census of agriculture, and required the use of six schedules which relate to florists' establishments, nurseries, and bulb, seed, mushroom, and blueberry farms. Complete returns were not received until February, 1931. The census advisory committee on horticulture, appointed last year at the general meeting of trade representatives, held a meeting on December 12, 1930, to consider the returns from this investigation and to recommend a plan of publication. It was decided to compile statistics for Pennsylvania first for study. Preliminary press announcements have now been issued for several States. These announcements give for each of the six branches of the industry the number, acreage, and value of establishments reporting, the number of persons employed, and receipts from sales. Tabulations have been completed for 25 States.

Irrigation.—Tabulation of returns for the census of irrigation, which included 19 States, is well under way. A series of preliminary press announcements for States, by counties, has been issued showing the acreage irrigated, the irrigating capacity of enterprises, irrigable acreage in enterprises, and the number of enterprises, with comparative figures for 1920. Copy for four State irrigation reports has been sent to the printer. These reports will show, in addition to the above data, the acreage and value of irrigated farms, irrigation works, investment in enterprises, and cost of maintenance and operation.

Drainage.—The area covered by the census of drainage includes 35 States. The last of the schedules for this inquiry were not received until May, 1931. A series of preliminary press announcements for States, by counties, giving the acreage of land in drainage enterprises, drainage condition, acreage of land in occupied farms, and capital invested, has been published for all drainage States; and copy for one final State report has been sent to the printer. The State series will include the following data, distributed by counties: Number of farms reporting drainage, acreage drained, condition of land in enterprises, drainage works, and capital invested in enterprises.

CENSUS OF MANUFACTURES

The collection of returns for the census of manufactures for 1929 was delayed considerably, chiefly by three factors: The industrial depression prevailing at that time, as a result of which many manufacturers reduced their office forces so that the employees whose usual duty it was to make census returns found it inconvenient to do so; the necessity for employing the same field force on the censuses of manufactures and distribution; and the increase in the number of inquiries on the schedules. The most important change made in the

inquiries on the manufactures schedules in revising them for use at the recent census was the substitution of value of products sold (shipped or delivered) during the census year for value of products manufactured, as called for by the schedules used at previous censuses. Objection to this change was made, however, by representatives of a considerable number of important industries, and as a result the former basis—production, not sales—for reporting was retained on the schedules for these and certain other industries. One of the several inquiries which increased the length of the manufactures schedules and retarded the completion of the canvass related to the distribution of sales, placed on the schedules in order to obtain data needed for the purposes of the census of distribution.

Preliminary industry reports.—Despite the delay in getting in the returns, the preliminary industry reports, 212 in number, were issued during the period from June 26 to December 31, and a general summary covering all industries was published on December 31, 1930, thus establishing a record. The reports were prepared as soon as the canvasses for the respective industries were complete. Since January 1, preliminary manufactures reports for States have also been compiled and published.

Final reports.—The sequence of reports for individual industries comprises two series, namely, the preliminary and the final. The material for the first final report, that on the manufacture of soap, was sent to the printer on June 30, 1931. The final reports present general statistics by States, detailed statistics on power equipment, statistics on wage-earner employment by months, detailed production statistics, and, for many industries, detailed statistics on consumption of principal materials. A series of State reports and a number of general reports, all in pamphlet form, will also be issued. Finally, the reports of the census of manufactures will be assembled and bound together in three of the volumes of the Fifteenth Decennial Census reports.

Census of manufactures, 1931.—Some preliminary work has been done during the last fiscal year on the revision of the schedules for the census for 1931. The scope of the inquiries will be materially reduced as compared with those for 1929.

CENSUS OF MINES AND QUARRIES

A total of 10,136 returns were received at the decennial census of mines and quarries, taken in 1930 as a part of the Fifteenth Decennial Census. The United States Bureau of Mines, as well as the various State bureaus of mines, cooperated in the canvass. The first preliminary reports were issued on October 31, 1930, and presented statistics on the production of Pennsylvania anthracite and of sulphur. At the close of the fiscal year preliminary reports had been issued for 13 industries, 10 other reports had been prepared for release in July, and summaries for all remaining mining and quarrying industries had been completed. A general summary covering all mining and quarrying industries, for the United States as a whole, and the State summaries were also in course of preparation at the close of the fiscal year.

CENSUS OF DISTRIBUTION

A census of distribution is an innovation in census taking, and the first national census of distribution is being successfully completed by the bureau. In this census, there were collected 1,549, 402 retail and 169,777 wholesale trade schedules, 153,461 schedules relating to construction work, and 25,817 hotel reports. The coding of wholesale schedules for final machine tabulation has been completed, and similar coding of the retail schedules will be completed within a month. The work of punching cards for these schedules is well advanced and the plan of publication of the results has been determined and is under way. Information as to distribution of sales between retailers, wholesalers, etc., has been taken from about 146,000 manufacturers schedules, and a large part of the resulting data has been published in press-release form.

Preliminary reports.—Preliminary retail trade reports have been issued for each city in the United States having 10,000 inhabitants or more, and wholesale trade reports for cities having 100,000 inhabitants or more. The retail reports show retail business in each city classified in detail by kind of business, and also show amount of sales of independent stores, chain stores, and other types of organizations. The wholesale reports cover the wholesale function in business. Both retail and wholesale reports show the number of establishments, the net sale, the number of full-time employees, the total salaries and wages paid, and the cost of stocks of goods on hand. A series of preliminary State retail summaries has also been published, and both wholesale and retail summaries for the United States as a whole have been prepared for publication. In addition, a series of publications has been started showing retail data by counties, by cities, and incorporated places down to 1,000 population.

Construction census.—A material portion of the work of gathering schedules on the construction industry has been conducted by correspondence; but this phase of the work was completed in February. Two preliminary reports on the construction industry have been issued, and plans for the presentation of the final reports on this subject have been determined. The work of coding the schedules for punching is about 50 per cent complete.

Hotel census.—Manuscripts for 38 State reports concerning the hotel business have been sent to the printer, and 12 State reports and 1 for the District of Columbia had been published at the close of the fiscal year.

VITAL STATISTICS

During the fiscal year 1931 the State of South Dakota met the requirement of 90 per cent complete registration and was admitted to the registration area of the United States for deaths. There are now 47 States, the District of Columbia, the Territory of Hawaii, the Virgin Islands, and 8 cities in the nonregistration State of Texas, in the death-registration area, which includes 96.2 per cent of the total population of the United States.

There are in the birth-registration area of the country 46 States, the District of Columbia, the Territory of Hawaii, and the Virgin Islands, including 94.7 per cent of the total population. Because of the greater difficulty in obtaining complete registration of births, only entire States rather than cities or other sections thereof, are ad-

mitted to the birth-registration area. Texas and South Dakota are still outside of the birth-registration area, but officials of those States are using every means to compel the registration of births, emphasizing its importance to individuals. It is hoped that forthcoming registration tests in these two States will justify their admission to the birth-registration area of the United States.

Birth and death registration certificates now carry an inquiry as to occupaion of father and of mother of the infant, or former occupation of the deceased, respectively, and it will, therefore, be possible hereafter to present occupational data in birth and mortality statistics reports.

In 1929 there were 1,386,363 deaths reported in the registration area in continental United States, for which the mortality rate was 11.9 per 1,000 population. In that same year there were reported 2,169,920 births in the birth-registration area, for which the rate was 18.9 per 1,000 population. This is the lowest birth rate recorded during the 15 years that this bureau has been compiling birth statistics.

Annual reports.—The publication of the annual reports of birth and mortality statistics for 1929 was delayed so that the 1930 population returns might be used in compiling rate tables. The manuscript for these reports will be forwarded to the printer shortly, however.

A special effort was made during the past year to bring about greater cooperation between certain States and the Federal Government in the collection of vital statistics. The chief statistician in charge of this work at the bureau visited a number of State officials in the far West and in the North to observe the methods used in these States for collecting vital statistics, and to offer suggestions and the facilities of the Census Bureau for the improvement of their methods toward better and more complete returns.

Reference books.—During the last fiscal year the bureau published a Pocket Reference of Information on Occupations and the Physicians' Pocket Reference to the International List of Causes of Death. The former is the first booklet on that subject to be issued by this bureau. The latter was revised as a result of the international conference at Paris, and is the eighth edition of this work. Copies of these booklets have been furnished to State officials for distribution to physicians, undertakers, local registrars, and others interested in vital statistics work. They are especially valuable as an inspiration for more complete and accurate statements from persons reporting births or deaths.

There is an ever-increasing demand for the bureau's reports on vital statistics and for special and detailed tables not presented in our printed volumes. The bureau has continued to issue the Weekly Health Index and the 4-week summary on mortality from automobile accidents during the last fiscal year.

Vital statistics are steadily assuming a greater national interest, and officials of this bureau are, therefore, frequently authorized to attend conferences relating to these matters. In particular, during the last fiscal year this bureau took an active part in the White House conference on child health and protection, preparing the greater part of the statistics used for the discussions. The bureau is also cooperating very actively with the National Conference on Nomenclature

of Disease, the National Safety Council, the New England Health Institute, and the Association of State and Territorial Health Officers.

MARRIAGE AND DIVORCE

Statistics of marriage and divorce continue to be received by the public with a high degree of interest. Close study is given to the preliminary summaries, which are issued for the individual States in advance of the annual report as rapidly as the data are received from the county officers. 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 more difficult. The reports for the surrounding States are carefully scanned by the press of the country with a view to ascertaining whether the border counties show marked changes in figures, and the results observed 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 each year by States and counties, as many requests for additional data are received—particularly data relative to the number of marriages performed each month and the age of the contracting parties. This latter item is of utmost importance in the study of child-mortality statistics. Fairly uniform information on a number of items relative to divorces granted and marriages annulled is obtained from court records.

The statistics of marriages are now obtained from some office of the State government in 29 States, and the statistics of divorces are likewise obtained from State officials in 16 States. In the other States county officials furnish the information.

On June 30, 1931, the work of securing the information with regard to marriages and divorces in 1930 was about 99 per cent complete, reports having been received for 1,119,342 marriages, 189,913 divorces, and 4,307 annulments, as compared with a total of 1,232,559 marriages, 201,468 divorces, and 4,408 annulments for the year 1929. Preliminary press statements have been issued for 41 States. From returns received it is apparent that the totals for the year will show decreases.

ANNUAL CENSUS OF INSTITUTIONS

The bureau is collecting annual statistics concerning State and Federal prisons and reformatories, State hospitals for mental disease, and State institutions for the feeble-minded and epileptics from the heads of the various institutions or from State administrative agencies. The 1927 report on prisoners was published in the fiscal year 1931, and that for 1928 is in process of printing. The 1928 report on hospitals for mental disease is being compiled. The 1926–27 report on feeble-minded and epileptics in State institutions was issued during the last fiscal year, and the tabulations for 1928 are practically completed.

This office felt great satisfaction in the passage at the last session of Congress of a law granting authority to the Bureau of the Census to " compile and publish annually statistics relating to crime and to the defective, dependent, and delinquent classes," as data of this

character have been collected at annual periods for the past few years because of the insistence of interested parties but without specific legislation. A number of conferences were held during the last year with individuals and representatives of organizations interested in social statistics. The advisory committee cooperating in the collection of prison statistics is having a complete list of prisons in this country compiled. This publication will be of much importance for census purposes.

FINANCIAL STATISTICS OF STATE AND CITY GOVERNMENTS

The annual reports covering the financial statistics of States and cities provide information relative to the financial administration of the governments of the States and of the cities having a population of over 30,000, reflect their financial condition, serve as a guide to the officials in planning future operations, and in extending or curtailing functions or activities, furnish assistance to officers who are charged with responsibilities incident to the administration of the governments, and enable the public to judge intelligently of the fidelity, efficiency, and economy practiced by their officials. Institutions of learning are using these census reports in connection with courses of study.

Since the inauguration in 1925 of the plan of having local officials fill out the census schedules relating to the financial transactions in their respective States or cities, rather than Census Bureau experts formerly detailed for that purpose, an ever-increasing willingness to cooperate in this way has been apparent. Whereas in 1925 officials of only 1 State and 17 cities cooperated, at present officials of 35 States and 170 cities are furnishing these reports. The principal subjects covered by the annual financial statistics reports are: (1) Total and per capita receipts from revenues and from the principal classes thereof; (2) total and per capita payments for operation and maintenance, interest on debt, and total outlays for public improvements; (3) total and per capita indebtedness; and (4) total and per capita assessed valuation of property and tax levies, and rates of levy.

The 1930 census shows 310 cities having a population of 30,000 or over, and it is planned to include reports for all of these cities in the city financial statistics report for that year.

On June 30, 1931, manuscripts for the annual reports on financial statistics of States and of cities for the fiscal year ended December 31, 1929, were in the hands of the printer. Work of compiling the schedules for 1930 for States was about 45 per cent complete, and for cities about 50 per cent complete on that date.

CURRENT INDUSTRIAL REPORTS

The bureau issues almost a hundred reports at weekly, monthly, quarterly, semiannual, or annual intervals, covering industrial fields. These reports have proved of interest to the general public and of great value to business organizations. The majority of them are issued monthly and include statistical charts. Of primary interest among them are those relating to the cotton industry. There has been a tendency on the part of Congress to authorize by specific legislation more and more frequent reports on phases of the cotton industry.

Annual reports were published from 1905 to 1909 on the supply, distribution, imports, and exports of cotton; four periodical reports were published each year from 1909 to 1912, and compilation of monthly statistics of cottonseed and cottonseed products was begun in 1916; and from time to time other inquiries relating to the cotton industry have been inaugurated and reports issued at intervals ranging in length from a week to a year.

Trade organizations are requesting additional current industrial reports continuously to supplement the reports of the biennial census of manufactures. Those issued at this time cover phases of the following industries: Textiles (including cotton, wool, and knit goods), leather (including boots and shoes), iron and steel, machinery, miscellaneous metal products, clay products, electrical goods, animal and vegetable fats and oils, glues, wheat and wheat flour, forest products, paper production and paper-making equipment, sand-lime brick, ties and poles purchased and preserved, vegetable materials used by tanners, and a number of others.

As may be seen by the foregoing, censuses of industry and business conducted by this bureau fall into two general classes. Those which are comprehensive and detailed, covering an entire field, and those which relate to a single item or to associated items, regarding production, sales, stock, etc. The two classes of inquiry serve distinctive purposes. Those that fall into the first class have a permanent value; but, because of the length of the schedules and the detail of published dates, it is often impossible to make the results of such censuses available immediately after the close of the canvass. On the other hand, the value of the second class of statistics lies primarily in the fact that the data are current and available to the public promptly. The schedules are short and relate to special phases of the industries involved. The prompt cooperation of business organizations in supplying census figures is immediately reflected by the prompt publication of census results.

TABULATIONS FOR OUTSIDE ORGANIZATIONS

During the last fiscal year the Bureau of the Census has made many special tabulations from the statistics resulting from the census of 1930 which have been paid for by persons requesting the service. For instance, population figures, by enumeration districts, have been supplied for Chicago and Cleveland, and by counties for New York State, at the request of the University of Chicago, the Cleveland Health Council, and the New York Telephone Co., respectively. In addition, detailed population figures, by tracts, have been supplied for Baltimore, at the request of the Baltimore Health Department; for Buffalo, at the request of the Buffalo Census Committee; for Columbus, at the request of the Columbus Chamber of Commerce; for Cleveland, at the request of the Cleveland Health Council; for Indianapolis, at the request of the Indianapolis Census Committee; and for the Boroughs of New York City, at the request of the Cities Census Committee (Inc.), New York City.

Many other tabulations have been requested by various organizations to be made at their expense.

OLD CENSUS RECORDS

As an evidence that census statistics touch the life of every individual in the country, it is of interest to know that 5,767 persons came to this office during the fiscal year 1931 and examined the old census records for genealogical or other purposes. In addition, there were 6,889 searches made of the population schedules by employees of this office at the request of individuals, for use of various Federal Government departments, especially the Pension Bureau, Civil Service Commission, and Navy Department; for use of State officials in connection with old-age pensions, as well as for other purposes.

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, 1931.

The honorable the SECRETARY OF COMMERCE.

DEAR MR. SECRETARY: A difficult business year has just closed. The United States, in common with other nations, is passing through a severe economic disturbance, the results of which are so widely known as not to call for special comment.

The Bureau of Foreign and Domestic Commerce, constituted as a great service bureau for the aid of American commerce and industry, has been called upon increasingly to aid in meeting the special economic problems which have faced business during this interval.

Because it provides a staff of experts in many fields, the bureau has been called upon by the legislative and administrative branches of the Government, as well as by business men, to present the facts in regard to various economic problems. Some idea of the usefulness of the bureau may be gained when it is stated that a new record in the number of demands upon the bureau has been established for the year just closed. There has been an increase of more than 1,000 requests a day as compared with the previous year, an increase of 9 per cent. The total number of requests for service amounted to 3,966,000; in the last week of the fiscal year 86,600 requests were received, as compared with 78,100 in the same period in 1930.

New demands are being made upon the bureau by organized trades and industries because of the business situation. As a consequence, the bureau is performing many services of an intangible nature which can not be evaluated directly in terms of new business or immediate savings. However, hundreds of letters have been received, acknowledging the constructive work of the bureau's staff in many lines. Of particular importance is the work of securing facts which only a Government body can obtain and the exchange of information regarding the best practices prevailing in individual trades and industries. Such interchange of information has been particularly helpful on the broad problems of the stabilization of employment, specialized trade promotion, balancing of production and consumption, elimination of wasteful methods in distribution, and related problems upon which the bureau has attempted to take some leadership.

Most of these services can not be evaluated directly in dollars and cents. However, the definite record of firms reporting new business and savings directly resulting from the bureau's work during the year amounts to $57,554,813, which is an increase of 13 per cent over the previous year. This record represents only 8½ per

cent of the number of firms for which the bureau performed similar services and it is reasonable to suppose that if the record were complete there would be a very large addition to the concrete evidence of the value of our work to American business.

The bureau cooperated in advancing the work of the President's Commission on Housing, the President's Committee on Employment, the Committee on Recent Economic Changes, and many committees of private and public character sponsored by business organizations such as the Chamber of Commerce of the United States, organized trades and industries, and the national organizations dealing with the functional services of business and trade.

THE DOMESTIC BUSINESS SITUATION

Domestic business activity during the past fiscal year reflected the continued decline into depression by world business. After a temporary improvement early in 1930, business activity declined until the beginning of 1931, after which minor fluctuations took place in what was apparently the trough of a cyclical depression.

The continuance of the world-wide decline in prices, especially of raw materials in the face of increasing stocks, led to uncertainty on the part of producers, with further curtailment of operations and decreased employment. At present prices, many raw materials are selling below actual cost of production.

Industrial production in the first half of 1931 was 16 per cent below the first six months of 1930, while in the same period a corresponding decline of 16 per cent in factory employment took place. Similarly, freight-car loadings dropped 18 per cent, while the wholesale price level declined 19 per cent. Department-store sales were relatively better maintained, however, falling off but 7 per cent. Business in general was unsettled throughout the fiscal year.

The large extent to which business activity in this country is dependent upon world conditions has become increasingly apparent. The world decline in the price and buying power of silver, the accumulations of large stocks of essential raw materials, and generally upset political as well as economic conditions in most countries have had severe repercussions in the United States, directly through curtailed exports and imports and indirectly through disturbed monetary and other conditions.

In view of this, the following summary of developments in our foreign trade and of economic conditions in our foreign markets for exports and sources of imports is of special significance.

FOREIGN TRADE

Our foreign trade during the fiscal year ended June 30, 1931, declined sharply in value. Total merchandise exports of $3,084,000,000 showed a 34 per cent drop, and aggregate imports of $2,432,000,000 a decrease of 37 per cent, from the totals of 1929–30. On a quantity basis declines were less severe, exports falling only 22 per cent and imports only 17 per cent. Important factors in the drop in our exports were the severe decline in prices, not only of

agricultural but also of mineral products, and the decrease in sales of finished articles to those countries whose purchasing power was reduced because of low prices received for their products.

The excess of merchandise exports over imports amounted to $651,000,000, in comparison with an excess of $845,000,000 in 1929–30 and of an average of $732,000,000 for the immediately preceding 5-year period. Every month but July and August of 1930 showed an excess of gold imports over exports; net imports of the metal for the fiscal year amounted to $297,000,000, an increase of $24,000,000 over the import balance in 1929–30.

The value of exports and imports by economic classes and trade regions in comparison with the value for 1929–30 is shown in the accompanying table.

Continent and class	Value in millions of dollars		Per cent decrease from 1929–30	
	Exports[1]	Imports	Exports[1]	Imports
Total	3,084	2,432	34.3	36.8
To Europe	1,523	719	29.9	39.5
To all other continents	1,561	1,713	38.1	35.6
Northern North America	530	334	36.2	31.3
Latin America	512	623	39.7	34.4
Asia	385	685	32.0	37.5
Oceania	64	25	59.9	38.9
Africa	71	46	39.2	47.9
Foodstuffs	457	591	30.6	29.4
Raw materials	725	765	29.7	41.6
Semimanufactures	405	454	36.4	42.2
Finished manufactures	1,446	623	36.9	32.1

[1] Total exports and exports by continents include reexports of foreign merchandise; exports by economic classes include only United States merchandise.

This decline in our foreign trade is due, of course, to the world-wide business depression. During the past fiscal year conditions became more acute in many foreign countries. Almost no spot on the globe was free from the devastating effects of trade recession. Conditions in Europe culminated in June with a threat of financial collapse in Germany. The President's moratorium proposal, negotiations for which were in progress at the close of the fiscal year, promised much in the way of relief.

The following résumé of economic conditions throughout the world indicates the difficulties which our exporters have faced. Of course, such conditions forced a reduction in our foreign trade, with a very unfavorable reaction on domestic conditions.

EUROPE

The trade recession, which for most of Europe began in the latter part of 1929, became a depression increasing in severity throughout 1930, and hopes of improvement with the spring of 1931 were largely disappointed. Few European countries reached the midyear in a satisfactory position from an economic standpoint. France and the Scandinavian countries were able to maintain a relatively high degree of commercial and industrial activity, and even of prosperity, until toward the end of 1930, when they, too, felt the effects of the generally weakened world market.

The period was marked by falling commodity prices, reduced industrial production, declining foreign trade, credit shortage, greatly increased unemployment, and generally lowered purchasing power. These adverse developments were aggravated by the psychological factor to which they had given rise and which was evidenced in hand-to-mouth buying, reluctance of investment, and a general policy of caution and retrenchment. Popular dissatisfaction with economic conditions in some instances sought political expression and so added a further disturbing element. On the other hand, stocks were very generally exhausted or reduced; and replacement costs were, at the same time, particularly low. Reduced purchasing power and lack of public confidence, however, prevented any marked increase in buying. The trend of wages was slowly downward, with employers attempting to cut production costs and labor resisting any reduction in living standards.

Harvests in 1930 were generally above average, and prospects indicated good crops for 1931. The return to the farmer at prevailing prices, however, was insufficient greatly to strengthen his purchasing power, in spite of the lower prices of farm supplies.

Industrial production, which during 1930 fell from the high level of 1929 to about that of 1928, continued to decline during the first half of 1931. Export industries were particularly affected by the general weakness of world markets and the severe competition for orders; domestic industries were slower to feel the depression, but reduced purchasing power and weakened public confidence reacted upon them also.

The most serious effect of the industrial depression was the great increase in unemployment, which reached record proportions in many European countries. Total German unemployment reached nearly 5,000,000 during the winter and did not fall below 4,000,000 until June. Unemployment in Great Britain totaled 2,700,000 in February, or about 22 per cent of industrial workers, and at the end of June still remained about 2,500,000. Italian unemployment nearly doubled during the year. The rise in unemployment greatly increased the demands on the various governments for measures of relief. The balance of the German and British budgets was seriously disturbed by greater requirements for unemployment insurance than had been anticipated. Many governments undertook to increase employment through public works, but in this they were hampered by the necessity for economy in public expenditure as a result of reduced revenue and the desire to avoid increasing taxes.

European public finances reflected the economic difficulties with which all countries were confronted during the year, and heavy budget deficits were the usual result. Tax returns, including customs duties, fell generally below estimates, showing reduced incomes, fewer commercial transactions, and lower imports. Revenues, consequently, were commonly less than were budgeted. At the same time the exigencies of the depression made heavy unforeseen demands on government treasuries, and in spite of administrative economies it was in many cases impossible to keep expenditures within the estimates.

European foreign trade in 1930 fell decidedly from the peak reached in 1929, and this decline continued unchecked through the first half of 1931. Exports held up better than imports, primarily because of the heavy decline in prices of raw-material imports but also because the dullness of domestic markets caused greater emphasis on export trade while discouraging imports. There was considerably less decrease in the volume than in the value of foreign trade.

CANADA

The fall in wheat prices and the continued poor export demand for raw materials and manufactures were seriously unfavorable influences for the Dominion during the year. All sections and all industries registered further declines. Severe trade and credit restriction in the west resulted from the rapid depreciation in grain values and, to a lesser extent, from drought, which had curtailed the production of some areas for the third successive year. Approximately $70,000,000 had been expended by the Dominion, provincial, and municipal governments and the railways in unemployment-relief works to the close of June. Three major tariff revisions contributed to the unsettlement of foreign trade, all of them increasing the rates in the general schedule applicable to shipments from the United States.

LATIN AMERICA

The entire region of Latin America remained in the grip of acute depression. Prices in consuming markets for the export products of all of the individual countries continued to decline, thereby drastically reducing national, corporate, and individual income. With insufficient financial resources to tide them over so protracted a period of inactivity, some governments have been unable to resist the force of popular discontent and have given way to new régimes; others have endeavored to stem the tide by adopting measures of relief. In several instances defaults or suspensions of services on the foreign debts occurred.

Mexico's troubles have been more economic than political, with the continued decline in prices for silver and other metals a basic factor. An ameliorating feature of the situation, however, is seen in the rapid growth of American tourist traffic.

Central America continued to suffer from the decline in coffee prices and the dwindling demand for bananas. In Panama and Guatemala revolutionary activities culminated in the overthrow of established governments.

Cuba's hopes were raised perceptibly toward the close of 1930 through the consummation of the Chadbourne effort to effect an agreement among the principal sugar-producing countries to restrict production; market prices, however, have shown no material gain, and the curtailed operation of the grinding mills and cane-cutting activity have added to the already serious problem of unemployment and discontent. The other islands of the West Indies have experienced similar distress, except in so far as they have been protected by colonial or mainland trade policies.

In Colombia, national elections have resulted in a notable degree of solidarity, and, despite low monetary returns from coffee, efforts have been made to adjust the balance of national and state trade. Retrenchments in the extensive oil fields of Venezuela have added to the nation-wide depression carried over from the previous year. Ecuador, Peru, and Bolivia have also passed through a very trying period as a result of declining revenues and stagnation of trade. Intermittent revolutionary outbreaks in Peru starting in August unseated several successive governments. In Chile, discouragement over continuance of the depression and the failure of the nitrate industry to recover its former activity following reorganization led to outbreaks of discontent. Argentina and Brazil witnessed the installation of revolutionary governments; while trade remains on a very low level in both, there are indications of a slightly more hopeful outlook for the future. While business conditions in Uruguay have been unsettled, owing largely to the weakened position of the peso, the value of the nation's exports has remained at a fairly satisfactory level. Paraguay, owing to the simplicity of its economic structure, was less influenced by world conditions than the other Latin American countries.

Depreciated exchange in practically all of the Latin American countries has been a factor of outstanding importance in preventing a revival of importing activity.

FAR EAST

The last fiscal year witnessed in China an almost complete duplication of the general conditions that existed during the previous fiscal year. A short season of peace with the promise of an established government and a certain amount of order was followed again by factional outbreaks; the end of the year found the recognized National Government beset by rebellions in both north and south, as well as engaged in vigorous military movements to overcome communist agitations in the Yangtze Valley. These administrative difficulties have served to keep China's commerce, both internal and external, in depression and distress. There has been no opportunity to improve internal lines of transportation and communication, which would insure the free movement of commodities. Silver exchange still remains upon a low basis, which, combined with low prices for Chinese products in world markets, has greatly curtailed both import and export trade, and kept China's purchasing power at a low point.

The general depression in Japan's commerce and industry that characterized 1930 continued unabated in the first half of 1931. Further restrictions were placed on industrial production, and large dismissals of factory workers ag-

gravated the unemployment situation. Conditions in rural districts were equally unsatisfactory, owing to the low value of farm products and increased debts of the farmers. Foreign trade continued at a low ebb. Export returns were reduced by the decline in commodity prices, particularly in the price of raw silk, and by the depression in principal far eastern markets which was intensified by the low level of silver. Owing to the industrial inactivity and general retrenchment policy as well as the decline in purchasing power, imports were restricted. An encouraging feature, however, was the reduction in the usually high unfavorable trade balance.

Unsatisfactory conditions prevailed in India throughout the year. The monsoon season was good and large crops were harvested, but prices for India's export commodities fell to very low levels, so that as the year closed little profit was being realized and in some instances export demand was nonexistent. Internally, business was seriously disorganized by strikes which centered about political movements, and by competition from imported commodities, particularly piece goods. Foreign trade declined considerably in value because of lower price levels and smaller volume, but the usual favorable balance was maintained. The jute and piece goods industries were hard hit, but the latter received relief in the form of higher duties on imported piece goods, particularly upon those qualities which come into more direct competition with local manufacturers.

Australia continued to make uncertain progress. Low price levels for all primary products reduced oversea balances further, and imports were curtailed drastically in response to reduced purchasing power, exchange difficulties, and the continuance of the emergency tariff measure. Unemployment grew increasingly serious as the year advanced, with little or no improvement noted at the close. The same factors are expected to depress imports during the coming year.

Crop yields were good in New Zealand, but price levels of all primary products, particularly butter, were very low, causing export values to decline. Acute unemployment throughout the year and exchange difficulties continued to handicap importers.

A steady decline in prices of rubber, tin, and sugar, leading products of British Malaya and the Netherland East Indies, caused general trade depression there throughout the past fiscal year, although a brief revival of optimism followed the improved world sentiment at its close. International agreements for the restriction of tin and sugar were entered into, and the possibility of forming a rubber-restriction scheme was under discussion at the close of the year. Foreign trade of both countries declined steadily and in the case of British Malaya, reverted to unfavorable trade balances, although consumption of imported goods was reduced to minimum requirements.

The depression which became general in the Philippines in the last half of 1930 continued with only temporary readjustments throughout the fiscal year. Unusually heavy stocks of leading export products, coupled with declining world demand, led to record low commodity values. Greater firmness and slight price increases followed the moratorium proposal, but business during the year as a whole was restricted and cautious, and foreign trade fell to the lowest levels in recent years.

THE BUREAU'S WORK IN DOMESTIC COMMERCE

The first appropriation for domestic commerce work in the bureau was made for the fiscal year ending June 30, 1924. At that time there was established a domestic commerce division, which was charged with carrying on the major activities in this field. From time to time Congress has seen fit to increase the appropriations available for studies in the domestic field, and this has resulted largely in increases in the variety of duties and the personnel of the domestic commerce division. At the beginning of the present fiscal year it was felt that these increases had reached a point where effective administration of the work could no longer be secured in a single division. A reorganization was effected which resulted in setting up three divisions in the place of the former domestic commerce division.

These divisions have been designated the merchandising research division, the domestic regional division, and the marketing service division.

Experience has shown that the most important work which the bureau can do in the domestic field is to carry out, in cooperation with organized groups of business men, fact-finding studies which private enterprise can not undertake successfully.

Along with the prosecution of such research work goes also the equal responsibility to see that the practical results of these studies are brought to the attention of the business public in such a way that they will be applied in the everyday operations of merchants and manufacturers.

In reorganizing the domestic commerce work careful consideration was given to these two functions. Two of the new divisions established are purely research organizations. The merchandising research division carries on studies dealing with merchandising functions such as costs, credits, sales efforts, consumer preference, industrial marketing, and related subjects. The domestic regional division was set up to handle research studies having particular regional aspects. These include commercial surveys of sections of the country, trade-area studies, and market data and commodity-movement studies.

The third division, known as the marketing service division, has for its purpose the dissemination of the results of the bureau's and other research in the field of marketing. Particular emphasis is placed upon getting these results before the business public in such a way as to secure their practical use. This is being done through press releases, speeches, exhibits, model stores, correspondence in answer to inquiries, and also through the stimulation of discussion programs by trade organizations, chambers of commerce, and other bodies. An effort is also being made to decentralize this work as far as possible through the use of our own district offices and through cooperation with local chambers of commerce in various parts of the country.

Efforts have also been made to develop the domestic commerce activities of the commodity divisions particularly by having these divisions act as the contact point with trade associations in their respective fields and thus to bring before such organizations the services which the bureau can render and the results of studies in their particular trades.

The work which has been accomplished during the year in the domestic field is described later. In general, the work has been carried on along lines indicated in previous reports, but the reorganization and expansion has resulted in expediting and facilitating the various surveys and has made them more valuable.

The bureau has received hundreds of letters from business men expressing appreciation of the work which it is doing and of the service it has been able to render. Most of this work is of such a character that it is impossible to give it a specific dollar-and-cents valuation. However, many of these letters state that the work has enabled them to effect economies in their operations ranging from a few hundreds to many thousands of dollars. The marking-device industry has stated that the work done for it was worth $1,000,000.

The results of the bureau's efforts in this field have been especially helpful during the trying times of the past year. Many firms have indicated that by applying the results of the bureau's work they have eliminated large amounts of wasted effort and have been able to turn threatened deficits into the profit column. The bureau feels that this work, which has proved itself effective in helping to eliminate many unnecessary wastes in distribution, should be materially strengthened. It is one of the methods by which the Government can greatly assist in the recovery from the business depression, and its results are of benefit not only to industry and trade but in even a larger way to all consumers through lower prices resulting from more efficient operation.

DOMESTIC REGIONAL DIVISION

The commercial surveys of the domestic regional division have found a distinct place in the business world as guides to intelligent distribution planning and sound commercial practice. Since the creation of this division three of these studies have been released: Commercial Survey of the Pacific Southwest, Distribution of Dry Goods in the Gulf Southwest, and Petroleum Industry of the Gulf Southwest.

The latter two studies mark a wide departure from the former survey plan in that each study covers a particular commodity in its field of distribution rather than an all-inclusive and somewhat general picture of distribution within a given area. As a result, these studies are more specific in covering expense of operating, methods of sales promotion, problems of buying and selling, stock control, advertising, and elements of competition. An evidence of their wide appeal is the fact that the original editions have been exhausted, and there is a gratifying accumulation of orders for the new editions.

Other survey studies that are in press are Cotton Production and Distribution of the Gulf Southwest, Distribution of Hardware in the Gulf Southwest, and Commercial Survey of the Pacific Northwest. Two new regional areas are being surveyed, the Mid-West and the West Midcontinent. A study of the distribution of furniture is now being carried on in these two areas as well as in the Gulf Southwest.

A supplement bringing up to date information contained in the Market Data Handbook of the United States is nearly ready for the press. Already many orders for it have been received. This work is being substantially improved by the issuance of one supplement to cover the general consumer market and another to cover the general industrial market. At the instigation of numerous manufacturers, advertisers, and agencies interested in marketing research a number of case studies are being prepared on the use of marketing statistics for the preparation of sales quotas and sales budgets.

Many current practical marketing problems begin or end with the need of more specific knowledge as to the physical movement of commodities within specified market areas. To fill this need the domestic regional division is now gathering information on the interstate and intrastate movement of 156 groups of commodities. This

information has been gathered for 40 States and supplemented by information from express agencies and air-transportation companies.

In addition to the technical market research carried on by the division, information has been supplied which has had an important bearing on the expenditure of over $50,000,000 by public-utility companies in certain areas of the Southwest. Commercial information has been supplied which has led to the establishment of a new air transport line. A special report was prepared on the commercial activities of southern Texas for the use of the Committee on Rivers and Harbors of the House of Representatives in its consideration of a proposed canal for that area, as well as a report in connection with a projected deep canal for the State of Florida.

MERCHANDISING RESEARCH DIVISION

During the fiscal year 1930–31 data obtained in the Louisville grocery survey were analyzed and 12 separate preliminary reports were issued on different commodity departments by the merchandising research division.

Two final reports on retailing, as a result of the study, were prepared during the year. The first, entitled "Costs, Markets, and Methods in Grocery Retailing," is now in press, and the second is in preparation. A report on the wholesaling practices found in the survey is now being prepared.

Many changes were reported in store arrangement, merchandising practices, and management in the 26 grocery stores and the various wholesale houses connected with the Louisville study as a direct outcome of that survey. Several retail stores have installed modern lighting systems, new shelves, and central-island display tables. Such remodeling has resulted in increased sales in practically every case, in some instances amounting to as much as 35 per cent.

In one retail store the application of the principles developed in the survey resulted in a sharp reduction in inventory, the elimination of stock which had been on hand for up to 25 years, and an increase in the volume of business from $80,000 to $96,000 a year.

In April, 1931, field work was commenced on the national drug store survey in St. Louis. This survey will be of the same character as the Louisville grocery survey, several stores being intensively analyzed in all of their merchandising operations.

In January, 1931, a study of store location in Baltimore, based primarily on the 1930 Census of Distribution, was begun. This study covers the location of all retail outlets in relation to local shopping districts, transportation facilities, and the number, racial characteristics, and income of the population in those districts. The field work of this study is practically completed.

A distribution-cost study of several manufacturing confectioners was completed during the year and the report printed.

The retail-credit researches were continued by making two semiannual tabulations for the periods January–June and July–December, 1930. Reports were published on these surveys for seven kinds of stores in 25 cities. These surveys make it possible to compare retail-credit conditions in 1930 with those in 1929.

A nation-wide survey of the credit practices of wholesalers, manufacturers, and commission houses has been started and is now in progress. This survey was undertaken at the request of the National Association of Credit Men and is being carried out with the active cooperation of its 145 affiliated associations.

A study of business failures, made in Newark, N. J., was completed and a report written. New investigations have been undertaken in Boston, Mass., and Chicago, Ill.

Work was completed, and reports prepared for publication, on three projects which were started during the previous year—a survey of machinery in knitted outerwear plants in Cleveland and two separate surveys covering operations of manufacturing jewelers and retail jewelers. The division was requested by the National Wholesale Jewelry Association to make a corresponding study of wholesale jewelry establishments, which is in progress.

Other studies in progress at the close of the fiscal year include a survey of manufacturing costs, marketing costs, and distribution practices of marking-device manufacturers; a census of capacity, output, and channels of distribution of drop-forging equipment; a study of capacity, output, distribution methods, policies, and expenses of manufacturers of public-seating equipment; a survey, in cooperation with the University of Alabama, of retail-management practices in five Alabama cities; and a study of retail delivery costs.

MARKETING SERVICE DIVISION

The steadily growing interest in the bureau's domestic commerce activities has been reflected in the consistent and increased demand on the marketing service division during the past year for bureau publications in that field.

The cooperation of some 60 trade associations resulted in the exhaustion of the initial editions of several survey reports within a few weeks of their appearance. In some cases trade associations undertook the publication and complete distribution of survey reports.

An evidence of the appreciation of the bureau's services in domestic commerce is seen in the ever-increasing number of requests for speeches before trade associations and other commercial groups and over radio networks. More than 100 radio talks on these services were prepared and delivered during the past year, and, despite a serious handicap in lack of travel funds, several hundred speaking invitations were accepted.

The 1930 edition of Market Research Agencies, published during the fiscal year, shows a steady expansion in the field of domestic market research by public and private organizations.

Another service in the domestic commerce field which shows steady growth is the bulletin Domestic Commerce, issued three times each month.

The small business unit expanded its work among mercantile interests which lack organized channels of approach to the bureau's services. It has encountered a growing demand for service to the negro business factors of the country. Work among foreign-language merchants and the smaller unorganized business interests generally showed a steady gain.

Efforts are being made to meet the demands of business for widespread and general application of domestic-commerce information, as evidenced by the increase to the record number of 18,548 individual requests for such service received during the year. In this service the bureau functions as a clearing house, not only for the results of its own research but also for new merchandising thought and experience of whatever source.

An extension program has been developed during the past fiscal year for closer cooperation with trade associations. It embraces the following points:

To provide such organizations with more complete informational material from which they can supply merchants and manufacturers directly with needed statistics.

To supply carefully digested information on particular merchandising subjects, to be made the basis of systematic discussion programs. Three such programs have already been completed, 9 are being prepared, and 30 are in prospect.

To provide retailers with practical demonstration of the benefits that follow modernization of store arrangement, by setting up model stores, at the expense of local trades or communities, under the guidance of a representative of the bureau thoroughly trained in such work. At Jacksonville and Orlando, Fla., retail grocery associations set up model grocery stores, illustrating the principles revealed in the Louisville survey. As a result, 357 stores in the State were modernized within a few months, all of them reporting increases in business, some of them up to 50 per cent. A general falling-off in grocery-store failures was reported by the grocery association. Similar model stores were set up at Des Moines, Iowa, and Norfolk, Va.

DOLLARS-AND-CENTS RESULTS OF FOREIGN TRADE PROMOTION

Each year the Bureau of Foreign and Domestic Commerce attempts an evaluation of the results of the services it has rendered. For many years past this total, which is based upon written statements of American firms, has continued to increase. Last year the report showed slightly in excess of $50,000,000. For the fiscal year 1930–31 the foreign trade of the United States shrank approximately 35 per cent in value. This factor of diminished export trade, due to unfavorable business situations in world marts and continued price declines, created a very unfavorable setting for the compilation of the dollars-and-cents report this year.

In spite of this unfavorable situation, the report for 1930–31 shows that American firms, as a result of the bureau's services, have received new business and direct savings to the extent of $57,554,813. The real significance of this increase lies in its coincidence with the increased figure for services rendered. This is no chance coincidence. It means that a large number of firms, as indeed several have stated, have, in their effort to reduce overhead, turned to the bureau for services and advice that have an immediate and tangible value.

Accordingly, the total of over $57,550,000 becomes this year a more significant percentage of our total foreign trade; it furnishes evidence

that in periods unfavorable to domestic trade the bureau plays an increasingly important rôle in the development and maintenance of our foreign trade. It includes very few estimates of the intangible services which because of their nature bar any evaluation, but which, nevertheless, constitute a large part of the total activity of our offices.

A glance at a few of the typical cases of assistance which have been reported gives an indication of the effectiveness with which we serve a wide range of industries.

Antiseptics.—Four of our offices were called upon to assist in the arrangement of connections for an exporter of antiseptics, and $25,000 worth of exports to Panama, Guatemala, Straits Settlements, and Venezuela was the direct result.

Automobiles.—One of the large manufacturers of Detroit lists $100,000 as the value of automobiles exported through bureau assistance.

Automotive specialties.—A mid-West manufacturer of these products states that two of our Latin American offices helped to secure two agents, and since the granting of the agencies $20,000 worth of business has resulted.

Beans.—Arrangements were made by our offices with importers in Habana and Mexico for the sale of American beans, and the domestic company concerned reports an export to them during the year valued at $22,000.

Canned oysters.—This commodity, through the assistance of the bureau, has been successfully introduced in four new foreign markets, namely, New Zealand, Australia, England, and Canada, and $10,000 worth of business has been done there.

Celluloid products.—An American firm dealing in celluloid products received last year a total of $10,500 in orders from the Canadian and Mexican agencies arranged by our offices.

Cereals.—Prepared cereals invoiced at $10,000 were placed on the markets of South and Central America with bureau cooperation.

Chemicals.—Through a contact made in London by our office there, a New York exporter of manufactured chemicals secured a $100,000 business during the past year. Through the assistance of our San Juan office one southern concern sold $19,750 worth of wood preservative in Porto Rico. To agents recommended by our Habana, Madrid, and Mexico City offices one western firm shipped $10,000 worth of animal serums and toxins. Another chemical concern reports that with general assistance in securing a foothold in nine different markets his export business last year directly traceable to our efforts amounted to $14,196. Agents in Cuba, Porto Rico, and Brazil, recommended by our offices in those countries, bought $30,000 worth of chemicals from another concern.

Citrus fruits.—One shipper of fresh grapefruit states that "the total amount of foreign business made possible to our concern during the past 12 months through the cooperation and aid extended by your bureau amounted to $325,000." Practically all of his shipments were made to the United Kingdom.

Cotton.—Although but recently opened, our Lisbon office was successful in aiding one shipper to export $13,476 worth of cotton to Portugal during the past few months.

Cotton gins.—At the suggestion of our Buenos Aires office one exporter started negotiations for the sale of his machinery which resulted in the sale of $40,000 worth in Argentina.

Cotton yarns and textiles.—Three southern cotton mills alone reported that, owing to the bureau's activity, they had exported $796,234 worth of cotton yarn and textiles to practically every corner of the globe. The desirability for outlets in the markets of South America for cotton prints and goods was called to the attention of a certain manufacturer; with the bureau's constant guidance and assistance, connections were arranged to which during the fiscal year 1931 he exported goods worth $262,875.50.

Dry-dock equipment.—A large New England firm received contracts valued at $260,000 from Belgium and France as a result of recommendations made by the bureau representatives in those countries.

Electric heating pads.—General assistance by the Boston district office and specific information from four of the bureau's foreign offices were responsible for the shipment of $50,000 worth of electric heating pads to Norway, Cuba, Canada, and Mexico.

Electrical motors and fans.—Our offices in the Orient and several of those in Europe facilitated the shipment of $10,000 worth of this equipment from one mid-western manufacturer to agents in their territories.

Flour.—A half million dollars, perhaps the largest single item ever attributed to the bureau for encouragement of export of an agricultural or horticultural commodity, was reported by one organization as the amount of business during the past year directly traceable to the efforts of this bureau. Bureau field men helped one Illinois miller to export $220,000 worth of wheat flour to the West Indies, Latin America, and Europe.

Fountain pens.—Eight foreign countries proved markets for one company's fountain pens during the course of the year. This firm estimates that the direct assistance we extended in these shipments brought a tangible return of $116,556 to it.

Hardware.—Ten thousand dollars worth of hardware was sent by one manufacturer to agents in Latin America recommended by our offices.

Leather.—Aid extended by our offices in Latin America, China, and Turkey is shown by one exporter to have resulted in $25,000 worth of business to those countries. One firm, listing $43,000 worth of export business to Canada due to our assistance, states "This represents only six months' business, to June 30, 1931, as we did not begin to derive benefit until about January 1, 1931."

Livestock.—One organization lists $25,000 as the value of horses and cattle exported with our assistance during the year.

Lumber.—Lumber invoiced at $350,000 sent to Mexico, Portugal, France, and Spain represents the tangible results of the bureau efforts for another exporter.

Machines and machinery.—As one of the results of the bureau's activity may be listed the export of $20,000 worth of hoists to Africa by one concern. Thanks to agents recommended by our Scandinavian and Latin American offices, one firm exported $22,500 worth of shoe-repair machinery. Our offices in the Netherland East Indies, Japan, England, and France assisted another manufacturer to ship mining machinery to those countries valued at $26,813. Cane-sugar mills, crushers, and auxiliary milling equipment for cane-sugar factories which had a total value of $500,000 were shipped abroad by one concern through assistance rendered by this bureau.

Paints and varnishes.—Auto enamels and lacquers valued at $45,000 were sold to agents in South America, Germany, and Denmark through the aid that our men stationed in those countries were able to extend to a certain mid-western company.

Paper and paper products.—Information furnished by our Mexico office enabled a Missouri firm to sell $93,000 worth of paper in Mexico and Central America. Another firm gives us credit for assisting in $250,000 worth of business to the British Isles, France, Germany, Italy, and Spain.

Prepared food products.—Macaroni and spaghetti valued at $110,000 are reported by another firm as being their export business directly traceable to the efforts of the bureau. These exports went to Panama, Mexico, and Haiti.

Radios.—One New York exporter reports that through the efforts of one of our commercial attachés in South America he was able to establish an agent who, during the first four months of his agency, has sent him business totaling $100,000.

Road-paving contracts.—Owing to a vast amount of assistance and advice of our Warsaw and Budapest offices, one American firm of contractors secured road-building contracts in those countries worth $600,000. In the letter acknowledging and thanking for this service it states: "We have listed for total amount merely our Poland and Hungary road-building contracts, totaling $600,000 which were executed in 1930. However, a number of new prospects have followed these, possibly exceeding $1,200,000."

Rubber products.—By keeping in constant touch with our offices in South America, several of the European offices, and the Johannesburg office, one New England firm reports exports to those regions valued at $18,000. Electrical tapes valued at $88,000 were exported by one manufacturer to England, Australia, Mexico, Argentina, the Netherlands, and Central America after a market analysis of foreign import statistics suggested and aided by the bureau.

Safety razors.—One of America's largest manufacturers of this commodity reports that the bureau made possible exports to Latin America and China valued at from $80,000 to $100,000.

Seeds.—Vegetable and flower seeds valued at $6,000 were shipped to Colombia by one grower. He gives the bureau entire credit for this transaction.

Shoes.—Trade-promotion work on the part of our Habana and Mexico City offices made possible an export of $27,550 worth of shoes to those countries by one firm. Owing to the bureau's activities in its behalf, another concern states $15,000 worth of new business and savings was made possible to it during the past year.

Sprayers and garden tractors.—A manufacturer of sprayers, dusters, and similar equipment reports $152,000 worth of new business through the assistance of the agricultural implements division and district offices, and a garden-tractor manufacturer closed an agency agreement which resulted in $45,000 worth of business during the first six months of its existence.

Structural steel.—Listed on our Exporter's Index only a year and a half ago, one firm states that $135,000 worth of business has been done during the past year through connections arranged for it in Canada.

Sulphur.—One large firm says, "With your cooperation we have made satisfactory sales of crude sulphur to Finland, Spain, and Mexico. Last year the largest individual customer of sulphur we had was obtained through your aid and this year we have again sold this same customer sulphur amounting to approximately $200,000."

Tanning extracts.—Even in the face of some very stiff foreign competition one dealer reports that through constant contact with certain divisions and offices of the bureau he exported $43,500 worth of his commodity to Europe, Japan, Cuba, and South America.

Tobacco.—Through the offices of our representatives in Europe, $25,000 worth of tobacco exports is reported by one organization of our tobacco region.

Transportation.—A local manager of one of the Atlantic steamship lines writes: "It is the writer's personal opinion that revenue accrued to our vessels from trade developed abroad by shippers in cooperation with your office is conservatively estimated at about $150,000.

AID FOR EVERY REGION

While the areas served by the bureau's district offices are not laid out with such a nice distinction for State lines as the following would indicate, this section shows at a glance how every region and State is a direct beneficiary of the services extended by the Bureau of Foreign and Domestic Commerce.

Alabama products that reached world marts last year through our cooperation include lumber to Panama, West Indies, and South America and paper bags to the United Kingdom. *Arkansas* sent tool handles to Australia and New Zealand, rubber products to India and England, and lumber to France; and *Arizona* sent plaster and plaster board to Mexico.

California exporters turned to the bureau last year for aid in the export of nursery stock to Guatemala, plaster and cement to New Zealand, scrap metals to Japan, chinaware to Canada, oil-burning ranges to Argentina, Phillippine Islands, and South China, grape juice to Porto Rico, evaporated milk to the Philippines, fresh fruits to Europe, dried fruits to China, Java, Italy, Germany, and Porto Rico, and pickles and catsup to China and Japan. *Colorado* commodities include beans to Cuba and Mexico, tents and awnings to Canada, mining machinery to Japan, Canada, England, and France, and medicinal solutions to Mexico and Porto Rico. *Connecticut* sold corsets to the West Indies and hardware in Mexico, Colombia, Chile, and Turkey.

Delaware concerns list among their shipments aircraft to Canada, Mexico, and Peru, rubber products to Philippine Islands and China, and dyestuffs to Latin America and Europe.

Again this year the bureau materially assisted the export of *Florida* citrus fruit to practically every country in the world. It

also aided the sale of ground oyster shell in the United Kingdom, Belgium, Germany, and the Netherlands, canned fruits to Sweden and Denmark, lumber to leading nations of Europe, and cement to Colombia.

Reports from *Georgia* firms indicate that our assistance has made possible shipments of cotton goods to Colombia, Peru, and Venezuela, hickory lumber to Japan and South Africa, and blankets to Canada.

Idaho shipped lumber to Canada. *Illinois* shipments have included blackboards to Central and South America; radios and parts to China, Brazil, and Egypt; insulating board to Siam, Colombia, Mexico, and Italy; machinery to Canada, Czechoslovakia, the Netherlands, and Belgium; oil and gas stoves to Argentina; railway equipment to Japan and Peru; prepared cereals to Colombia; and electric bulbs to Sweden. From *Indiana* handles were sent to the Netherlands and Australia; pianos to Italy, England, Egypt, and Switzerland; silk hosiery to Germany, the Union of South Africa, and Egypt; machinery to India; and paper boxes and plates to Canada and South America. *Iowa* produce sent abroad includes paper specialties to South Africa, the Philippines, and Venezuela; fountain pens to Denmark, England, France, Germany, and the Netherlands; prepared cereals to Norway; machinery to Argentina and South Africa; and livestock to New Zealand.

Kansas, through the bureau's effort, furnished flour to the markets of Ireland, Venezuela, and Colombia, toilet articles to Japan, and seed to Brazil and Cuba. *Kentucky* tobacco found markets in England, Belgium, Germany, Denmark, and China; cooperage stocks were moved to Canada, and hardwood lumber was sold in the United Kingdom.

Paint and varnish from *Louisiana* was sold in Latin America with our assistance. Lumber was sold in Germany and Venezuela, canned oysters in England, Canada, and New Zealand, cotton in France, and naval stores in Europe.

Maine paper products went to the British Isles, France, Germany, Italy, and Spain. Shoes from *Maryland* were sold in Latin America, paint from the State in Italy, oil burners in Switzerland, insecticides in Egypt, and overalls in France. Through assistance rendered them *Massachusetts* shippers have sent biscuit machinery to Guatemala, groceries and provisions to Cuba and Colombia, shoes to Great Britain, Sweden, Canada, Porto Rico, Cuba, Panama, and the Philippines, leather to Latin America and Turkey, phonographs to Mexico and South America, chemicals to India, Philippines, Argentina, and Greece, rubber products to England and Germany, textiles to Canada, and paper to the Caribbean area. *Michigan* has sent automobiles to the Netherlands, Belgium, Norway, Denmark, and South America. Another company reports that, through our advice and aid, it shipped automobiles to practically every civilized country. Motor boats were sold in Latin America, automotive specialties in Denmark, South Africa, the Netherlands, Spain, and Switzerland, and spark plugs to Canada, Turkey, and the Gold Coast. Pipes and fittings were moved to Mexico, Cuba, and South America, show cases to the Netherlands and Denmark, and leather to China and the South American republics. *Minnesota* exports invoiced for shipment abroad contained such items as matches to Canada, stoves and heating

appliances to Denmark, Finland, and Czechoslovakia, dairy products to England, flour to Greece, Scotland, Holland, Denmark, Central and South America, and animal products went to Norway and Sweden. *Mississippi* iodine products went to Latin America. *Missouri* producers of insecticides and disinfectants sent their product to Porto Rico, Cuba, and Mexico, X-ray films went to England, Denmark, Switzerland, and Belgium, electric motors and fans to Latin America and Europe, oil burners to Denmark and Norway, pecans to France and England, and talking-picture apparatus to Canada, Spain, Mexico, and India.

Nebraska producers availed themselves of the services of the bureau, with the result that tents and awnings were sent to several countries; laboratory products to Canada, Belgium, and the Scandinavian countries; and shoes to Argentina, Italy, and Cuba. *New Hampshire* shippers listed sporting goods and paper specialties exported with our help to South Africa, Chile, and Peru. *New Jersey* products went to practically every corner of the globe. Some of these were copper products, printing presses, machinery, and chemicals. From *New Mexico* pottery and watches were sent to Mexico and the Netherlands, and alfalfa meal was shipped to England, Scotland, and Denmark. *New York* wall board went to Australia; beds and bedding to Greece and China; beekeepers' supplies to Cuba; surgical appliances to Italy, India, Poland, and China; electrical appliances to Canada, Mexico, Argentina, and Venezuela; machinery to Latvia; parachutes to China; vegetable oils to Canada; radios to South America; cleaning fluid to England; piece goods to the Straits Settlements, Turkey, and Guatemala; and phonograph records and needles to the Far East. Exporters from *North Carolina* applied to the bureau for assistance, with the result that tanning extract was sold in Japan and England; cotton yarns were sent to Argentina, Scandinavia, England, and Australia; mica to France; tobacco to Germany and the Netherlands; machinery to Venezuela; and crude drugs to France. *North Dakota* seeds found markets in Canada.

Ohio manufacturers were successful in marketing stump pullers in Rumania; household appliances in Canada, England, and France; steel office furniture in South Africa; road-building machinery in Panama, Portugal, and the Philippine Islands; rubber balls and toys in European and South American countries; and chewing gum in the Netherland East Indies, China, Denmark, England, the Netherlands, and France. The State of *Oklahoma* credited the bureau with assistance in shipping oil-well equipment to Poland and Rumania and gasoline and lubricating oils to Germany, England, and France. *Oregon* sent ready-cut houses to Venezuela; swimming suits to Guatemala, the Netherland East Indies, and Straits Settlements; apples to France; doors to England, France, and Belgium; and chemicals to Canada.

Our representatives aided in the establishment of agencies for *Pennsylvania* lubricating oils in France, England, Spain, Cuba, and Japan; automobile polishes and greases in the United Kingdom, Italy, France, and India; radio sets and parts in France, Hungary, Czechoslovakia, Austria, Germany, Denmark, and most of the South American countries; fresh fruits in Germany, France, and England;

varnishes in Canada and Mexico; mining machinery in South Africa; plumbing fixtures in South America; and phonographs in Argentina and Colombia.

Rhode Island's foreign trade listed such sales and agencies as office appliances to several countries, rubber products to China and Japan, radios to Mexico and Canada, and steel products to the Philippines, all made through our assistance.

Wood preservative from *South Carolina* was sold in Porto Rico, oyster products went to Latin America, and lumber went to England. *South Dakota* shipped auto accessories to England, France, Norway, Sweden, Denmark, and South Africa.

Tennessee lumber found satisfactory distributors, through our cooperation, in Argentina, Porto Rico, Mexico, Portugal, Spain, France, and Scandinavia. Raw cotton was shipped to England and the Netherlands, chemicals to Peru and Mexico, and hosiery to Guatemala and India. *Texas* producers have opened up, with bureau aid, new markets in Brazil and Turkey for machinery. Wheat flour went to Cuba, Mexico, Colombia, Guatemala, and Porto Rico; horses and mules went to Central America; fruit extracts and concentrates to South America; poultry feeds to Porto Rico; biologicals and serums to Spain; cotton to England; and musical instruments to Mexico.

The establishment of an office in Salt Lake City greatly facilitated the export of *Utah* honey to Germany, France, Belgium, and England.

Vermont sent fire clay, paper products, pipe organs, and talcum powder abroad. Exports of *Virginia* coal went to Canada, paper products to South Africa and India, fountain pens to India, jute bagging to Canada, hosiery to Porto Rico and Peru, leaf tobacco to England and Germany, apples to Denmark and the United Kingdom, fertilizer to South America, and agricultural implements to a dozen foreign countries.

The export invoices of *Washington* contain such items as lumber to Uruguay, hardware to Japan, foodstuffs to China, Japan, England, France, Germany, the Netherlands, and Uruguay, soda-fountain equipment to Japan, textiles and feathers to Germany, England, and China, electric-refrigeration equipment to Cuba, Brazil, and Argentina, and pears and apples to Europe. Canada purchased white-oak timbers and walnut logs from a firm in *West Virginia*, and Mexico and several of the South American countries purchased souvenir novelties, post cards, and knives. *Wisconsin* dairy products were shipped across the border to Canada, sporting goods went to Italy, milking machinery to South Africa, tractors to Mexico and Egypt, construction machinery to Cuba and France, bacon and lard to Italy, outboard motors to Latvia, India, Norway, Java, England, and France, and leather goods to China and Japan.

OPPORTUNITIES FOR MORE EXTENSIVE SERVICE

The work of the bureau may be divided broadly into two classifications—that essential for carrying on the international trade of the United States and that concerning the development of domestic trade.

In the field of foreign trade promotion, over a period of years, the Bureau of Foreign and Domestic Commerce has not only become a source of facts and of expert opinion, but has established itself as a center for formulating the foreign trade policy of the United States. In work for the promotion of foreign trade, the bureau has an established organization and personnel, world-wide in its scope and services. During the coming years this great staff to American industries and trade will probably be called upon as never before to meet the problems of international competition. It is probable that as specific demands arise under the new world economic conditions, it will be necessary for the bureau to extend certain of its activities abroad in order better to serve the interests of the United States in our international trade.

The second broad function of the bureau, namely, the development of domestic commerce, is only at the beginning of its possible service relationship to business in the United States. Many other branches of the Federal Government render service to domestic business in this country, including such organizations as the Department of Agriculture, the Interstate Commerce Commission, the Federal Trade Commission, and numerous others. In our own Department of Commerce there are bureaus devoted primarily to the promotion of great branches or functions of American business, particularly the Bureau of Mines, the Bureau of Fisheries, the Bureau of Standards, the Patent Office, the Aeronautics Branch, and others.

For the most part, the services of these bureaus are rendered to the great productive industries, such as agriculture, mining, forestry, fisheries, and manufacturing. In addition to these there is in this country intricate machinery of distribution, including the marketing function of manufacturers and the activities of wholesalers, jobbers, commission men, retailers, and others. The Bureau of Foreign and Domestic Commerce is the only organization of the Federal Government attempting to serve those millions who earn their livelihood through merchandising activities. The vast total annual business of commodity distribution in this country has for the first time been determined during the year just closed by the new Census of Distribution. These figures, totaling $53,000,000,000 in retailing and $70,000,000,000 in wholesaling activities, show the enormous importance of this phase of our business activities.

It is clearly recognized that the most important problems facing American business to-day and in the years immediately ahead are those of distribution and marketing. Vast wastes are occurring through ignorance of the possibilities of particular markets and the best methods of reaching them; through the uneconomic methods of handling commodities and of carrying on business. These preventable wastes are taking a large toll from American consumers, unnecessarily raising the prices which they have to pay for commodities, and, consequently, limiting the market for other products of our farms and manufacturing establishments.

With a total appropriation available for domestic commerce activities far less than that expended on research by many corporations, the bureau in the last few years has been able to assume a leadership in the field of market research which is recognized throughout the country. The work of the bureau in this field has so far been developed along three major lines.

The first of these has been the assemblage of a staff of competent men, expert in problems of distribution, whose services are available to carry out comprehensive fact-finding studies in cooperation with and at the request of organized trades and industries. Although this work has been strictly limited to the type of studies which can not well be carried out by private organizations, yet the demands made upon the bureau are far greater than it can undertake. These activities represent largely pioneering work in the fields of market research, analyses of costs of distribution, credit research, and similar undertakings.

For 20 years efforts have been exerted in this country, both in the Government and in organized industries, to establish principles of production management which lead to low-cost production. No such degree of experience is available in the field of market management. The domestic commerce work of this bureau is directed toward the establishment of such principles as will make for low distribution costs. This work already has had favorable results in savings to American business.

The second phase of the domestic commerce activities of the bureau consists in the collection and publication of commercial statistics as an aid in guiding business judgment. In this work the commodity divisions of the bureau, through their intimate contact with particular trades and industries, have been of special service in guiding the work along practical lines. With the cooperation of organized trades and industries, this work has a wide opportunity for further development, depending primarily not on an elaborate Government participation but rather on the education of our organized trade groups as to the way in which they can put to work the present services of the bureau in these and many other directions.

The third phase in the development of our domestic commerce work has been in the direction of extending service to the great merchant group. Research work which is not translated into practical application to business problems is of little immediate value. During the past year special efforts have been made to bring the practical phases of our own and other research work to the attention of merchants in such a way that they can put these principles into practice in their own establishments. Through coordinated efforts with trade organizations and local chambers of commerce, the bureau has a very practical opportunity to serve as a great educational center for making the best practices of the individual the common practice of all. Such preliminary work as has been done indicates the importance of strengthening our business fabric by the reduction of credit losses, the reduction of failures in individual businesses, the reduction of specific wastes in distribution, with decreased costs and eventually lower prices because of the savings thus brought about.

In this projection of the work of the Bureau of Foreign and Domestic Commerce, it may be said briefly that our present staff constitutes a service organization for establishing in the United States the principles of economic planning, so much talked about and so little understood. As a matter of fact, this bureau has helped to formulate, with many industries, specific programs for their development and rehabilitation which, fundamentally, constitute

economic planning in a broad sense. In the sense that economic planning is not a theoretical phrase, but a point of view of management, that it presupposes the control of production and distribution costs with the sense of the social responsibilities of the manufacturer and merchant, as well as his profit obligations to himself and his stockholders, the bureau constitutes a fact-finding and commercial research organization at the service of American industry and trade in extending the benefits of economic planning to producer, manufacturer, and distributor alike.

THE FOREIGN COMMERCE SERVICE

The type of assistance rendered to American industry by the foreign representatives of the Department of Commerce is influenced to a great extent by conditions prevailing in the territory of each office. In spite of the world-wide depression of last year these foreign-trade scouts were able to effect 2,873 new agency and sales connections. Approximately 1,600 new connections were made in 1929–30.

INTANGIBLE BENEFITS TO AMERICAN FIRMS

Probably the most important services rendered to American industry, however, by the foreign corps must be classed as "intangible" in character, for the reason that no possible way exists to measure the benefits accruing from them to American industry. As a matter of fact, a large part of the "tangible" results, so called, might truly be included among the intangible, as in estimating the dollars-and-cents benefits resulting therefrom no cognizance is taken of the effect of these tangible services in future years. Time and space do not permit a description of the intangible services rendered. Brief mention is made, however, of a few of the outstanding or most unique services of the intangible class consummated in the past year.

A national association of foodstuffs manufacturers whose product is made from an imported raw product estimated that the crop forecasts of one of our foreign offices has resulted in a saving to that particular industry of at least $1,000,000.

Documents permitting the sale of disinfectants and pharmaceuticals in a near eastern country were obtained for a Connecticut corporation, a New York manufacturer of insecticides, a St. Louis disinfectant company, and a Massachusetts producer of cattle and sheep dips.

Manufactures falsely advertised as of American origin were withdrawn from a Mediterranean market and a precedent firmly established whereby such unfair competition can be successfully combatted.

Through intervention with the proper authorities of a European country an American steamship company has been able to maintain its established services without the necessity of making heavy financial deposits. In one case a refund of a fine of several thousands of dollars was actually obtained for the American steamship company.

A far eastern government, at the request of the American trade commissioner, has provided the ground and personnel for an experimental farm for the purpose of trying out American power-farming equipment.

Carefully selected trade lists supplemented by sales information describing each of the firms contained in the lists are submitted to American inquirers in response to every trade inquiry. Moreover, in cases where even the slightest possibility exists that a demand can be created or augmented for the commodity involved, representatives of the foreign offices personally interview firms in an endeavor to place the sales franchise of the inquirer. Direct assistance of this sort is especially helpful in times of economic depression when so many firms have endeavored to effect a reduction in expenditures by limiting the number of their foreign sales representatives.

On the other hand, knowledge of local firms and of local conditions has enabled our foreign offices to serve American inquirers in a negative manner. During the widespread unfavorable economic conditions of the past year the foreign representatives did not hesitate to advise American firms, when the occasion warranted, to keep out of certain markets which, for one reason or another, did not offer a hope of profitable business.

In other cases timely reports regarding the apparently precarious financial condition of foreign firms have undoubtedly saved American companies from large losses.

EFFORTS FOR INCREASED EFFICIENCY

The consular-coordination plan invoked during the previous fiscal year in Great Britain has been extended to include France and Germany. The results of this arrangement have been so satisfactory that plans are being made to apply it generally throughout the service.

In its endeavor to place the knowledge and services of foreign commerce officers directly before the public the bureau continued its practice of sending field officers on itineraries throughout the United States to confer with business firms. During the year a total of 37 such oversea representatives of the Department of Commerce visited an average of 12 cities and held an average of 29 interviews in each place. The mutual benefits resulting from these personal relationships can not be overestimated. Not only are the American firms able to get a better view of foreign markets and foreign firms, but the field man himself becomes better acquainted with the products and problems of the firms he interviews and is thus in a better position to serve American business when he returns to his post.

A plan was evolved during the year whereby it is hoped to effect a reduction in cable charges without affecting the efficiency and celerity of the reporting service. One of the means adopted in this connection is the more extensive use of air mail, especially in the dispatch of letters and reports to and from Latin America.

The bureau had 59 offices in the principal commercial centers of 46 countries last year. New offices were opened at Bangkok, Belgrade, Hong Kong, Lisbon, and Tientsin. The total personnel of the foreign service, consisting of 199, was composed of 38 commercial attachés, 23 assistant commercial attachés, 59 trade commissioners, 70 assistant trade commissioners, and 9 American clerks. In line with the consular-coordination plan the Hamburg office was closed. The Peiping office was also closed, the commercial attaché and his staff transferring to Shanghai.

The serious effort made by the foreign-commerce officers to develop new business for American exporters is partially illustrated by the following statistical information concerning the work of these representatives. More than 17,000 reports on foreign markets were prepared during the fiscal year ended June 30, 1931, an increase of more than 1,000 over the preceding year. During the year 8,084 informational cables were received from the foreign offices. Informational letters to American firms increased from 40,000 in 1930 to 47,000 in 1931, while informational letters to the bureau increased from 40,000 to 42,000. These substantial increases were made despite an increase of less than 3 per cent in the appropriation available for the foreign-commerce service.

DISTRICT AND COOPERATIVE OFFICE SERVICE

At the beginning of the fiscal year 1930–31 there were 31 district and 44 cooperative offices in the more important trade centers of the United States. In October new district offices were established at Charleston, S. C., El Paso, Tex., and Salt Lake City, Utah, and during the year new cooperative offices were opened in commercial organizations in Anniston, Ala., Longview, Wash., and South Bend, Ind.

The number of commercial services rendered by the 34 district offices during 1930–31 totaled 3,524,370, as compared with 3,214,278 the preceding fiscal year. This increase of almost 10 per cent shows the greater use made of the facilities of the district offices during the difficult period through which we have been passing.

DISTRIBUTION OF TRADE OPPORTUNITIES

The district offices distributed 942,580 " trade opportunities " during the year. These were opportunities for the sale of American products throughout the world sent to the bureau by representatives of both the Department of State and the Department of Commerce and made available to American business firms through the district offices. Many firms in this country attribute their success in foreign trade to following up these trade tips, and use this means constantly in making new connections abroad.

TRADE LISTS FURNISHED

The branch offices furnished American manufacturers and exporters with 731,502 trade lists during the year. These lists give the names of importers in foreign countries to whom it is possible to sell American products. They cover all lines of business and list buyers in almost every country in the world.

An exporter of tobacco says of this service:

> The trade lists which you have furnished us of the tobacco trade and industry have opened up trade channels in at least two countries—Ireland and Argentina—we having made shipments during this month to both countries against firm orders on cash terms.

A radio manufacturer states:

> We entered the export field only about four months ago. Prior to that time the writer was accumulating lists and data which you had furnished. Our

first mailing during the month of March resulted in approximately $10,000 worth of business, April approximately $10,000, May $12,000, and June, we estimate, will amount to $15,000. We attribute at least 50 to 60 per cent of this business to your assistance. Your lists have proved very valuable.

PERSONAL CONTACT BETWEEN DISTRICT OFFICES AND PRIVATE BUSINESS

A total of 171,523 persons visited the district offices during the past year. All types of problems were brought to these offices for solution. Some visitors called to confer with traveling oversea representatives of the Department of State and this department, and others came to confer with foreign business men in this country to purchase American goods. Foreign business men are given letters of introduction by our foreign officers to district office managers, which bring such visitors in contact with American firms.

Another form of effective contact is that achieved in foreign-trade meetings held throughout the country. The district offices play a large part in arranging such meetings, which are for the purpose of discussing export problems with manufacturers. These meetings offer means for group or individual conferences with bureau experts from Washington and the Foreign Service. Conferences of this type were held in Boston, Buffalo, Indianapolis, Kansas City, Cleveland, New York, Philadelphia, St. Louis, and many other cities.

COOPERATIVE OFFICES

As stated previously, there are 47 cooperative offices of the bureau maintained in the more important commercial organizations in cities where the bureau does not have district offices. These offices have, during the past year, contributed greatly to the effectiveness of the district office service. They have relieved the district offices of considerable detail work and have also been instrumental in distributing trade opportunities and trade lists. They have held trade conferences and taken care of foreign visitors.

NEEDED EXPANSION

For the past five or six years the number of commercial services has been constantly increasing, and if the district offices are to keep pace with the increased demands made upon them, further funds should be provided to staff the present offices adequately.

Furthermore, a few additional district offices should be provided to round out the district office service; and funds should be secured for placing bureau personnel in the more important cooperative offices.

CONCRETE COMMODITY SERVICE FOR AMERICAN INDUSTRIES

AERONAUTICS TRADE DIVISION

With the curtailment in domestic sales and production, the industry's demands upon the aeronautics trade division for assistance in the past fiscal year were greater than ever before. To meet this demand the services inaugurated during the first year of existence were expanded. The weekly supplement to the Handbook for the Aeronautics Exporter, prepared by the division and published by the

Aeronautical Chamber of Commerce, was expanded to include data on the foreign budgets for aeronautics expenditure, and, with the collaboration of the commercial intelligence division, more data on overseas importers and dealers suitable for handling American aviation products.

The division contributed leading articles for the principal aviation magazines. At the suggestion of the division a prominent trade journal devoted an entire issue—part of which was translated into Spanish and had wide circulation in Latin America and the Far East—to international aviation and trade. Two articles prepared in the division were used, and suggestions made by the division were followed as to other editorial content. Publicity was prepared in the division, and in some cases translated into foreign languages, on United States aeronautical achievement and products, which received widespread coverage through both foreign and domestic field offices.

As was true during the fiscal year 1929–30, the division was associated, either through its own initiative or in its capacity of clearing house for work accomplished, in behalf of the industry by foreign offices of the Department of Commerce and Department of State, with at least one-half of the aeronautics exports during the fiscal year 1930–31. In this connection one of the industry's most prominent manufacturers writes:

> There have been instances of actual business produced through the cooperative efforts of particular foreign offices totaling, roughly, $250,000, and in addition to these actual orders there are now pending contracts on which we have received a great deal of help from your foreign offices, running well into 6-figure amounts.

A survey was started on the distribution of aircraft in the United States, which is intended to aid the sales manager in allocating distributor and dealer territories and determining the extent of his market, and servicing organizations in locating their facilities more strategically. The collaboration of executives in the industry, a prominent statistician, a professor of merchandising, the Aeronautical Chamber of Commerce, and the trade press was obtained in projecting and developing this detailed survey.

Bulletins on airports, flying conditions, and regulations in Canada and Italy were published.

In addition to the routine informational service, including the publication of a weekly bulletin on foreign aeronautics, circulars, maps, and statistical reports, numerous special studies and reports for official use of this Government and aeronautic interests were made.

The assistance of the Aeronautics Branch was especially helpful during the year.

AGRICULTURAL IMPLEMENTS DIVISION

With the trade in agricultural implements during the fiscal year 1930–31 in a rather depressed condition, due to the general agricultural depression throughout the world, the agricultural implements division succeeded in maintaining its service on nearly the same plane as in the previous fiscal year, which was one of the most successful in history. During the year 1930–31 the implement export

trade fell off more than 23 per cent, while the services rendered the industry through the division and the district offices fell off only 9 per cent.

Trade promotion through the cooperation of the foreign offices, district offices, and the agricultural implements division was particularly gratifying during the year, and a number of important trade contacts were effected.

Publication in Commerce Reports of market reports from foreign offices of the bureau and the Department of State were well received and served to keep the industry informed of important developments in all the important markets. Statistical statements released in Commerce Reports and through division special circulars kept the industry posted on the export trade throughout the year. Through the medium of special circulars and short items in the division's implement and tractor notes, the industry was kept further informed of developments in the foreign implement situation.

Excellent reports were received from consular officers, one of particular worth being a monthly report from the American consulate at Cobh, Irish Free State, on exports of Irish tractors. This circular, the only available official publication dealing with the manufacture and sale of Irish tractors, was in great demand from persons both within and without the implement industry.

Two trade information bulletins were released during the year, one on the manufacture and sale of farm equipment in the United Kingdom and the other on the demand for American farm equipment in Yugoslavia.

Throughout the year contact was enjoyed between the division and the National Association of Farm Equipment Manufacturers, which comprises 85 per cent of the industry, in this way extending the bureau's services to a much greater number of manufacturers than would otherwise be possible. In this connection the division gave particular assistance to the association in compiling data and doing special research work in the preparation of material to be used at a recent meeting of great importance to the implement trade. This was in addition to the customary routine service rendered the association.

AUTOMOTIVE DIVISION

Every year except one since its organization in 1921 the automotive division, with the cooperation of the bureau's district offices, has shown an increase over the previous year in the number of services rendered to the automotive industry. In the fiscal year ended June 30, 1931, such services totaled approximately 300,000, representing an increase of about 5½ per cent over 1930, 19 per cent over the peak business year of 1929, and more than 1,600 per cent over 1921. The number of special publications increased 100 per cent, and all of the weekly publications of the division were expanded and improved. For example, the Automotive Foreign Trade Manual and the Automotive World News now have new sections showing monthly market surveys of foreign countries and other information. Also, the format of those publications has been changed to make them more readable and interesting.

A constant flow of educational material went forward to the foreign offices of the Department of State and Department of Commerce and the domestic offices of the bureau. The results of this procedure have been reflected in better and more comprehensive reports from the field. Regular weekly reports of the American automotive production and sales situations were sent to field officers.

Among the division's new services established within the past year are:

A monthly report to the industry of oversea stocks of American and foreign vehicles by countries and price ranges.

A world survey of potential foreign markets for American parts, accessories, and garage equipment. In this the division anticipated industry's need, as export trends clearly indicated that our foreign trade in those products had suffered relatively less than in the case of complete vehicles.

Various studies of automotive and highway development in major sections of the world.

At the beginning of 1931 material dealing with export prospects for that year, prepared by the foreign offices, was sent to motor executives, who indicated that they especially appreciated these data covering specific products by individual countries and wanted the service to be put on a regular annual basis.

A new domestic-commerce study has recently been undertaken and the ground work for another one is being laid.

The division, with the cooperation of the bureau's foreign offices, assisted in paving the way for the sale of a considerable amount of automobiles and accessories in the foreign markets.

CHEMICAL DIVISION

Realizing the intimate relationship that exists between chemical research and industrial progress, the chemical division extended contact with professional and scientific organizations to the mutual benefit of science and industry. The cordial relationship existing with more than 35 trade associations was enhanced, and through these collective agencies much information and assistance were made available.

Already existing statistical services have been amplified and otherwise modified to make them most useful. During the year the quality of service established in previous years has been maintained, with the result that the domestic producer has been enabled to determine those lines and markets most profitable to enter, continue, or discontinue, as the case may be.

Bulletins on the chemical industries and trade of Germany, Great Britain, France, Poland, Czechoslovakia, and Portugal were published. The trade commissioner specializing in chemical reporting at Berlin was delegated to conduct similar surveys for Norway, Sweden, and Denmark. In addition to these major publications, there was published a series of special reports covering markets abroad for various kinds of polishes, paints, pigments, disinfectants, and toilet preparations.

Of decided value to American manufacturers and consumers has been the type of information which the chemical division continues to furnish in an increasing quantity covering foreign exotic

materials and competitive processes and technique. A series of reports was published on production and methods of marketing various foreign gums, and the division maintains a number of periodic services whereby information is made available covering such items as naval stores, tung oil, and other natural materials. Locating sources of supply of various essential raw materials has received continued and increasing attention. As an example of this activity, the chemical division, through the foreign representatives of the department, combed practically the entire world seeking out hitherto unknown sources of certain crude botanicals, most notable among which are psyllium seed, extremely important in medicine, and derris root, an insecticide.

Essential raw materials under foreign monopoly control continue to receive attention, with the result that domestic sources of supply have in many instances been established. The chemical division has been most assiduous in its endeavors to develop domestic sources of supply of synthetic nitrogen, and efforts to promote home production of potash have been fostered in every way. Synthetic camphor and synthetic menthol are other instances, and the chemical division has been of assistance in having established a rapidly growing acreage in our Southern States for the production of tung oil.

The division is vigorously participating in the national drug-store survey now being conducted in St. Louis by the merchandising research division. A pharmaceutical expert has been detailed to that survey. A distribution survey is in progress covering consumption of naval stores, and other activities of a similar character are under consideration.

ELECTRICAL EQUIPMENT DIVISION

There were some outstanding developments during the year regarding the work of the electrical equipment division which should greatly affect the distribution of electrical appliances and radio sets. The transfer of the division's quarterly surveys of dealers' and wholesalers' stocks and sales, both radio and appliances, to the Census Bureau placed them on a definite basis. The radio survey was formerly carried on through the cooperation of the Electrical Manufacturers' Association.

As an adjunct to this information the division cooperated with the National Electric Light Association in compiling a count of electric meters, classified by kinds. Such a count of meters had not been taken since 1925.

A study was made of the materials entering into the manufacture of radio sets, and a detailed study of radio-dealer operations was continued as in former years. This information is now available for 1928, 1929, and 1930, and is being worked up as a comparative study.

Circulars giving the type of electric current available have been consolidated into three groups, covering Europe, Latin America, and the rest of the world. These circulars cover the majority of inquiries, as they list the principal cities. Detailed circulars on the different countries are gradually being completed in order that they may be published in a single volume.

The bulletin on world radio markets was again revised and was received even more favorably than before. During the year a new mimeograph service was started, giving lists of broadcasting stations. These lists are of three types—one giving detailed information, arranged by countries, on the various stations, their call letters, wave lengths, etc.; the second giving a list of addresses of these stations; and the third presenting details of North American stations, with variations in time, etc. These three lists are kept current by supplementary correction circulars.

An innovation during the year was the occupancy by the division of a booth at the annual trade show held in Chicago by the Radio Manufacturers' Association. Splendid assistance was rendered by the airways division of the Bureau of Lighthouses.

Two trade information bulletins were published during the year, one entitled "Electrical Equipment Market in the Netherland East Indies" and the other "British Market for Electrical Appliances." In addition to "Radio Markets of the World—1930," referred to above, a trade promotion series publication on the Electrical Equipment Market in the Union of South Africa was issued.

Increased interest in foreign trade was evinced during the year by numerous requests from companies new to the foreign field. Telephone companies continued to receive service regarding foreign concessions. Exporters are apparently becoming more and more interested in having information regarding the foreign markets in greater detail than they have received in the past. In a number of instances actual samples, where not too bulky, were sent abroad for companies requesting help in securing agencies. A new form for the purpose was printed for the division, which, when filled out, gives complete information to field men.

FOODSTUFFS DIVISION

During the past year most of the efforts of the foodstuffs division have been directed toward perfecting and improving well-established services, although several new projects have been considered and a few projects undertaken.

Among the new activities was a cooperative enterprise with the New York Canners' Association and the New York State Labor Department in making a study of cannery operations in western New York State. The purpose was to determine the causes of periodic congestion and overtime work in these plants, with the hope also of discovering whether there were any important wastes that might be eliminated or management problems that could be solved.

Arrangements have been made, in cooperation with the National Canners' Association, to collect statistics quarterly on stocks of canned goods in warehouses of canners, wholesalers, and chain stores.

Cooperation has been undertaken with the American Bottlers of Carbonated Beverages in the development of monthly figures on the production of beverages, covering 11 different flavors.

The publication Per Capita Consumption of Principal Foods in the United States proved very popular, and arrangements are being made to keep information on per capita consumption as nearly up to date as possible.

Other publications that might be mentioned are a series of four short bulletins on the market for fruit juices and sirups, covering the various world markets, and two bulletins covering the production of raisins and currants and the canned-fruit industry in Australia. In all, during the year the division issued or collaborated in 2 publications in the Domestic Commerce Series, 4 in the Trade Promotion Series, and 12 Trade Information Bulletins.

This division cooperated with the University of California in sending an expert to the Far East to make a complete survey of the possible market for American food products in the territory extending from Japan and northern China to India.

The Accra office has completed a survey on cocoa production on the Ivory Coast, and also palm-oil production in Nigeria and the Gold Coast.

Our foreign-service work on the exports of fresh fruits has been considerably expanded and developed into a regular and important reporting service.

HIDE AND LEATHER DIVISION

American tanners, in their efforts to cut losses and keep up production, turned last year even more actively to the intensive cultivation of foreign markets, despite the reduced purchasing power in those markets. This was evidenced by the greatly increased number of inquiries received by the hide and leather division and by the 32 per cent increase in service letters to members of the industry. Tanners were advised throughout the year regarding trade conditions in those countries which afforded outlets for improved sales and were also cautioned against granting unwise credits in some markets where collections were slow. There is ample evidence that these services were appreciated by the industry.

Special circulars and confidential notices in the Foreign Markets Bulletin advised leather exporters of possibilities for making good connections in specific markets. Publications were compiled and released to the industry concerning the leather requirements of such markets as Czechoslovakia, Germany, and Japan. These contained suggestions for improved trading methods and also other informative data necessary to assist in the expansion of the sales of American leathers.

The interchange of agency information and the better utilization of foreign agents has been intensified and expanded during the past year. The service of weekly analyses of foreign markets by countries through the medium of Commerce Reports has been found so useful to the trade that it has been continued as a permanent feature.

The visit of the American leather trade commissioner for Europe to this country resulted in personal conferences with individual firms and was of great practical value to the industry. The intensive investigations of the trade commissioner handling leather in China, covering markets for American leather and studies of the cattle-hide and goat-skin trade of China, have been invaluable. The voluminous manuscript for the Raw Stock Manual was practically completed at the close of the fiscal year. Undoubtedly the most interesting and

useful publication released by the division during the year was Trade Information Bulletin No. 728, Marketing American Leather in China. Through the efforts of the leather trade commissioners in Europe and in China, the sections of the Leather Export Manual dealing with those areas have been expanded.

At the suggestion of the division's advisory committee, the hide and leather division is working up a card index detailing the types of leather sold by each American tanner. This will be revised annually and will be furnished to the consular offices and the foreign offices of the bureau as a reference compilation in answering inquiries for American leather.

The division has continued to assist in the marketing of reindeer skins from Alaska and the utilization of their by-products. Work has continued in cooperation with the interdepartmental committee on the conservation of domestic hides and skins.

The new committee of the American Leather Chemists Association has already formulated a program including a division of work among the various Federal departments interested in the studies for the better utilization of domestic tanning materials, creation of new domestic sources of supply, and researching the entire field of mineral and synthetic tannages.

INDUSTRIAL MACHINERY DIVISION

The curve representing American industry machinery exports rose from 1922 until late in 1929 from $112,000,000 to $263,000,000, and toward the end of this period industrial machinery was being shipped from the United States at nearly $1,000,000 a working day—a huge total. The world-wide depression in the fiscal year just closed forced contraction in this trade.

During the year the division has given even more careful attention to opportunities for the sale of industrial equipment abroad, and as a consequence new business for American machinery manufacturers that can be directly traced to the assistance of this division is already known to approximate $700,000 and probably will be found to exceed $1,000,000 when all reports are in.

During the year the division published bulletins describing the machinery markets of South Africa, British Malay, and Siam, the sawmill and woodworking machinery markets in western, central, and eastern Europe, dairy equipment in Latin America and the Far East, and Industrial Machinery—1930, describing the world's machinery trade and the American position therein.

On the domestic side the division has conducted a survey of the mechanical equipment in certain industries with relation to excess factory capacity, depreciation experience, and the influence of obsolescence. Much valuable information has been developed and the report is now in preparation. It is expected that the results developed will prove of value to other industries also.

The division has also devoted much attention to an analysis of the market for industrial machinery in the United States, efforts that are attracting interested attention from a wide community. Better sales management has resulted, and manufacturers indicate that the methods developed are not merely assisting to eliminate the wastes

of distribution heretofore experienced in this trade, but are also resulting in increased sales and more scientific coverage at reduced costs.

IRON AND STEEL DIVISION

The activities of the iron and steel division during the 1930–31 fiscal year followed closely those lines which have in the past proved most effective as a means of supporting the operations of the domestic industry, and, while the recorded volume of trade declined along with that in virtually every other major commodity line, the division feels rewarded in the 7 per cent increase in the number of services rendered and in the steady growth of its contacts as measured by the divisional exporters' index.

As in past years, certain of the products handled by the division seemed to predominate over others in the volume of interest and inquiry concerning them. Chief among these were steel fabric for construction work, automatic oil burners, munitions of war (including tear-gas equipment), corrosion-resisting steels, and secondhand rails—all, of course, in addition to the usual volume of inquiries concerning the other categories of iron and steel and hardware products.

The division was active in its work of securing the adoption of American engineering standard specifications by foreign municipal, State, and Federal Governments; through special research covering outlets for the products of specific companies; and by means of a series of articles on Latin American markets for steel products secured from and through the cooperation of bureau and consular officers in that territory.

The closing months of the year also were marked by the publication of the first issue of the Iron and Steel Fortnightly, a biweekly pamphlet containing a wide variety of items of interest to the iron and steel trade generally. This publication, the need of which was long felt, is now reaching approximately 1,700 contacts of this division and has had a most gratifying reception.

Trade information bulletins published during 1930–31 included the titles "Czechoslovak Iron and Steel Industry," "Market for Cooking and Heating Appliances in Canada and Latin America," and "Belgium-Luxemburg Iron and Steel Industry."

LUMBER DIVISION

On June 1 American Pitch Pine and Its Uses, prepared by the lumber division in cooperation with the National Committee on Wood Utilization and the Southern Pine Association, was released. This is the second of a series on American woods prepared for exporters to distribute abroad; foreign uses are emphasized, and numerous illustrations and drawings are included to appeal to foreign buyers. The first of the series on Douglas fir was issued in cooperation with the Northwest lumber organizations in both English and Spanish editions. Thousands of copies have been purchased by exporters.

The new series of foreign lumber-sales manuals, in revision of the 1923 series, now covers South America, Germany, Spain, Italy,

and South Africa, the last having been issued during the past year. The bulletin covering Caribbean countries is in press. Complete information on sales methods in all foreign countries is available in various bulletins of the division.

Through the foreign offices of the bureau and American consuls detailed information on foreign container markets has been secured. A bulletin on foreign cooperage markets is in preparation, and one on foreign markets for boxes, crates, and packages is to follow. A handbook for American lumber exporters has been practically completed. The service manual for lumber exporters was revised to include all assistance available in the department.

For a chapter in the bulletin on wood construction in the Tropics, prepared by the National Committee on Wood Utilization, information has been obtained from offices in tropical and semitropical countries as to the proper methods to follow in selling preservative-treated lumber.

Domestic conditions caused increased interest in foreign markets, and the division was called upon much more for foreign agency suggestions. During the year some 1,155 such suggestions were made, about a 45 per cent increase over the previous year, and it is estimated that 250 of these resulted in permanent or trial connections. Annual revision of the foreign lumber agency file was continued in cooperation with the exporters to the end that exporters desiring new connections may be put in touch with foreign firms not already handling the same lines for American competitors.

Close cooperation has been maintained with the National Committee on Wood Utilization in extending its recommendations to the export trade, as well as with the various lumber associations. The division is cooperating with the Timber Conservation Board.

In cooperation with the Bureau of Entomology of the Department of Agriculture, data on termite prevention have been supplied American fabricators and Latin American erectors of ready-cut buildings. Numerous export opportunities have been brought to the attention of American firms, hickory ski stock has been sold in northern Europe, ash for baseball bats and tennis rackets in Japan, and preservative-treated marine and railroad material in Latin America.

MINERALS DIVISION

During the fiscal year 1930–31 two phases of activity developed to a point that signifies a definite trend and consequently may serve to influence the future policies of the minerals division: (*a*) The need and demand for assistance in analyzing problems pertinent to domestic marketing or distribution of manufactures, and (*b*) the requests from governmental and trade organizations for aid of an advisory character with respect to current conditions abroad, constitute fields in which the division has been occupied actively during the past year.

The extent to which nonferrous scrap metal competes with and may substitute for primary metal is a subject that has become of vital importance to consumers, producers, and dealers. At the request of the trade and with the cooperation of three major trade associations, the division inaugurated a domestic survey covering the origin, flow,

and distribution of secondary copper and brass during 1930. There is evidence that the trade may require such a survey on an annual basis.

A study of the distribution of gasoline and lubricating oil through domestic filling stations is being conducted in collaboration with the Bureau of the Census.

During the last half of the fiscal year the division has endeavored to assist the structural clay-products industries through cooperation with an organization that represents seven trade associations. Close attention has been given to the procurement of adequate trade statistics and to the solution of problems in the present system of distribution.

The increasing amount of time and effort spent by the division's specialists serving in an advisory or consultant capacity to both Government and trade agencies is justified, despite the often intangible character of this service; during the year current résumés have been prepared for other Government organizations covering such topics as control of world petroleum resources, the Russian oil situation, manganese from a world viewpoint, etc. Illustrations of this type of service are a study on State versus private control and operation of foreign petroleum refineries, a listing of services available to the clay-products industries through the Department of Commerce, a report on current conditions in the Russian anthracite-coal industry, etc.

Effective January 1, 1931, a clay-products unit was established in the division to serve primarily as a contact point between the department and the structural clay-products industries.

During the fiscal year the division compiled material for publications on the international trade in petroleum in 1930, fuel and power in Latin America, the status of the British coal industry, and cement markets of the Western Hemisphere. Periodical publications of the division were continued. They include Mineral Foreign Trade Notes and Petroleum Foreign Trade Notes, biweeklies; International Coal Trade Situation, monthly; Foreign Petroleum Statistics, monthly; World Gasoline and Kerosene Prices, quarterly; and Special Cement Bulletin and Antimony Exports from China, both monthly.

Importers and consumers of essential raw materials of which the United States has an inadequate supply to meet its industrial requirements (asbestos, antimony, tungsten, mercury, tin, fluorspar, etc.) have consistently solicited the division's cooperation in connection with current problems relative to supply.

MOTION-PICTURE DIVISION

The fiscal year 1930–31 brought to the motion-picture industry a number of pressing problems. Theater receipts slumped sharply from the abnormally high level of the preceding year. In the equipment field the saturation point on theater wiring in the United States has nearly been reached. The foreign market for American pictures showed a marked falling off, not only in non-English speaking territories, where an effective solution of the language problem has not been reached, but also in countries where English-language pictures can be shown.

This general situation was reflected in the work of the motion-picture division. Requests for its services, which increased by about 20 per cent over the 1929–30 fiscal year, assumed a somewhat changed character. Many of them sought information on problems connected with the domestic field, particularly with relation to changed business conditions. On the other hand, film distributors and, to an even greater degree, equipment manufacturers, have shown increased interest in sales abroad by repeated requests for data from foreign markets. A special feature of such calls for assistance is that the majority of them involved constant requests for service extending, in the case of several companies in the equipment field, over a period of months.

The publications of the division were devised primarily to cover those markets of the world which heretofore had not been treated. Thus, trade information bulletins were issued dealing with the major Latin American countries and markets in the Far East except Australia, New Zealand, and India. The bulletin on China, originally put out in 1926, was brought up to date, and special material on the smaller island areas of the world (which still provide a substantial outlet for silent pictures) was issued in bulletin form. The fourth annual bulletin on the European motion-picture industry completed the printed publications. In addition, 54 foreign market bulletins embracing brief data on various phases of the film trade in individual foreign countries were issued, and the division's weekly press release covering current film news now goes to a special mailing list of 115 publications.

The industrial and educational work of the division is centered in a nontheatrical section. A marked interest in business films has been evinced by a sharp increase in the number of services rendered to all types of commodity manufacturers as well as the larger companies producing these films. Numerous publications in this field have been issued, including a complete survey of the use of educational motion pictures in the primary and secondary schools in the United States and also a list of nontheatrical film sources. A report on the value of business films for trade-promotion purposes is now being prepared.

The motion-picture trade commissioner in Europe, as in past years, performed services of outstanding value to the industry. His reports—over 200 in number—furnished an accurate index to conditions in that important market. He was of inestimable value, also, to the field men of the department and to the branch managers of American film companies in Europe in the face of difficult legislative situations in a number of continental countries.

PAPER DIVISION

The year 1930–31 was marked by depression in the paper industry, and both production and consumption of paper and paper goods showed a decrease. Competition in all lines was noticeably strong, since exports of paper and paper products as a whole decreased by about 18 per cent in value. This drop was accounted for largely by the fact that our exports included increased quantities of paper products of lower value, actual volume being estimated to have

decreased by only about 6 per cent as compared with the previous year.

Active assistance was rendered by the paper division to manufacturers of all lines of paper and board as well as of printing machinery and supplies, and full information was furnished them, either in published material or in correspondence, regarding economic conditions affecting markets for their products. The actual number of services performed for exporters in connection with markets during the year was 33,275, an increase of slightly more than 1 per cent over last year. A greater number of these, however, concerned new markets for paper-specialty lines.

Market investigations were made on behalf of firms manufacturing tissue papers and varied lines of writings and papeteries, while printing-equipment concerns were assisted in finding outlets and representatives abroad.

Cooperation with the industry through the trade associations has been continued on an increased scale. A special statistical survey of the world's international pulp trade was completed, as was also a portion of a similar work in connection with finished paper. The preliminary work on a manual or glossary of paper terms and designations in six languages as used in international trade was completed and sent abroad for final revision and correction.

During the year 1,008 items of special interest to the trade were published in the weekly Side Runs of the Paper Trade, and 308 trade opportunities also appeared both in that bulletin and in Commerce Reports.

The addition of one member to the staff of the division during the year has permitted the completion of several important pieces of work concerning the market and industrial situation abroad that heretofore could not be adequately handled.

RUBBER DIVISION

The major statistical study of the rubber division in 1930–31, published as a special circular, is entitled "Domestic Renewal Sales of Automobile Casings." This study begins with renewal sales of 1,525,000 automobile casings (7.84 casings per car annually) in 1910, and ends with 40,000,000 casings (1.65 per car annually) in 1930. The difference between the average annual tire consumption per car in 1910 and 1930 illustrates very strikingly the immense improvement in tire construction during the period. American and foreign rubber-trade papers, practically without exception, reprinted this statistical study in its entirety.

The survey of automobile tire stocks held by distributors on April 1, 1931, in the entire United States, a semiannual survey which has been conducted since 1924, was of increased interest this year because the stocks of tires held by factory-operated retail stores, mail-order stores, and oil-company and other chain stores were for the first time included with those of independent retailers.

The decline in rubber-goods exports and growing foreign competition has made increased foreign-market analysis desirable, while the low price for rubber has somewhat reduced the necessity for increased research on domestic production. Confidential circulars re-

viewing the trend of exports for different sections of the industry were prepared and distributed as soon as complete statistics for 1930 became available, a special effort being made to encourage exporters of rubber sundries and specialties, trade in which continues to show considerable strength. A start has been made on maintenance of current detailed records of international competition in each market for rubber footwear and automobile casings; continuance of this work depends on personnel facilities. Changes in international competition in these lines are occurring so rapidly that semiannual reviews are no longer satisfactory guides to exporters, and current monthly records are the only means of keeping abreast of developments.

In the last two months of the fiscal year all manufacturers of rubber products who were not already receiving division services were circularized. As a result, numerous additional companies have become clients for the crude-rubber services of the division, and others have become subscribers to export services.

During the year the division issued weekly circulars and news letters on world movement of and developments in crude rubber and weekly and monthly circulars covering foreign markets for all classes of rubber manufactures. Other subject matter issued consisted of 301 circulars, 126 statistical statements, and 54 corrections to the division's loose-leaf manual of foreign import duties on rubber manufactures.

SHOE AND LEATHER MANUFACTURES DIVISION

The past year has been rather trying to the boot and shoe and allied industries because of restricted sales abroad as well as in the domestic markets. This factor has caused an increase of 12.7 per cent in the number of commercial inquiries received by the shoe and leather manufactures division during the last six months of the fiscal year.

The division mailed questionnaires to more than 5,500 contacts advising them of helpful trade information, domestic as well as foreign, now available in the bureau, and to date over 25 per cent have requested material which should be useful to them.

An important conference was held with Army officials relative to the assembling of shoe-repairing outfits for use in Army camps.

Close cooperation has continued with the various advisory committees and trade associations. The assistance rendered the War Department, in advising when to place contracts for Army footwear, has resulted in a considerable saving to the Government.

Charts were prepared for the Navy Department to show production trend of men's footwear. The graphic charts drafted for use of the trade associations have been given publicity in several of the important trade magazines.

Monthly presentations and interpretations of import and export statistics and digests of reports received from consular officers, commercial attachés, and trade commissioners concerning the markets in various countries for footwear and allied commodities have been published in Commerce Reports.

SPECIALTIES DIVISION

As announced last year, a special survey abroad was made by the specialties division on behalf of the makers of coin-operated machines. As one result of this survey a series of bulletins has been published covering the metal and paper currencies of practically every country of the world. In addition to the coin-operated machine industry, many others have profited from this survey. Bankers, automobile manufacturers, the motion-picture industry, and various Government agencies have found it very helpful.

A special service extended to the Olympic games committee has resulted in the accumulation of a vast amount of data on the development of sports in foreign countries. These data are being used as a basis for a comprehensive publication on sports abroad, the manuscript of which is nearing completion.

The usual cooperation was maintained with a large number of trade associations coming within the specialties field. The Business Equipment Institute held its annual meeting in Washington, and a special program was arranged for the benefit of its members for the purpose of showing the various new special services which might be extended by the bureau to this important industry.

During the year the division cooperated with the broom-manufacturing industry in the formation of the Broom Manufacturers Institute—accomplished at a meeting in January held under the bureau's auspices. It has since aided in the establishment and adoption of standard grades of brooms and in a program for understanding and acceptance of those standards.

With the cooperation of the National Association of Book Publishers, a new export classification for books was established with a view to giving American publishers accurate figures showing exports of American publications.

Because of its increasing importance a special mailing list has been built up to take care of the hotel and restaurant field. The wide range of commodities falling in this field had made it heretofore extremely difficult to service this group adequately through existing channels.

The St. Louis drug-store survey provided a further opportunity for the division to plan studies of value to the industries producing specialties—books, vending machines, soda fountains, glass and pottery, furniture, photographic goods, smokers' supplies, sport goods, stationery, and many others.

In the field of export advertising, the specialties division completed a triennial revision of lists of advertising mediums, and carried out an unusual number of special researches. Advertising Abroad, a summary of foreign news of interest to advertising men, is now issued monthly.

Because of the increasing need for special and selective servicing of the large group of industries represented in the specialties field, it was found necessary to revise the specialties section of the Exporters' Index completely. Although this work was started in January, it will probably not be completed until the end of August. It

has entailed a vast amount of clerical work, justified only because American manufacturers listed with the specialties division will be assured of more prompt and efficient service and of receiving material of specific interest to them.

TEXTILE DIVISION

Trained specialists in certain foreign markets—notably Australia, British Malaya, the Netherlands East Indies, and the Philippines—have served to stimulate interest in American textiles and aided in maintaining sales on a fairly satisfactory basis.

As in preceding years, the division attempted to secure the maximum results in its trade-promotion work by referring specific trade opportunities, submitted by field officers of the Department of State and Department of Commerce, to firms equipped to supply the articles desired. The division continued its usual services in the dissemination of pertinent information on current trends in textile producing and consuming countries through the medium of bulletins dealing with specific textile commodities. In cooperation with the bureau's foreign offices the division made a survey of Latin American markets for rayon and hosiery, the cotton-goods market of British Malaya, and world markets for leather cloth. It also issued a bibliography of dry cleaning.

Services of the textile division and the district offices to the textile industries during the period under discussion recorded an increase of 24 per cent over the previous 12 months and of 38 per cent over 1928–29.

The division continued to collaborate with the Cotton Textile Institute (an organization of cotton manufacturers representing approximately two-thirds of the industry) and the Department of Agriculture in the search for new and extended uses for cotton. A pamphlet, Cotton and Miniature Golf, issued by the division, called attention to this new industry as a potential outlet for a number of cotton products, such as tents and awnings for coverage, canvas folding chairs, table sunshades, and similar appurtenances. Outlets for canvas curtains and various other cotton furnishings were suggested by another release on the solarium. Consumer interest was also stimulated by the distribution through retail channels of a booklet which listed numerous articles of cotton as acceptable and in some cases unique Christmas gifts. The division also issued a revision of Cotton Fabrics and Their Uses, first compiled in 1928.

The division was active in securing the adoption and wide use of a new letter material (recently developed by cotton manufacturers) for manuscript in broadcasting programs. This new cotton letterhead was found free from the disturbing crackle often audible to the radio audience when ordinary paper is used. Special exhibits showing the use of cotton products in the automobile, shoe, and other related industries were prepared for loan purposes and displayed at "cotton festivals" in Memphis and Houston.

These attempts to develop new uses for cotton and to extend old uses have attracted favorable attention abroad. The British cotton industry in particular has resorted to various publicity methods, including a National Cotton Week and trade exhibitions, to stimulate the consumption of cotton products.

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TOBACCO DIVISION

The tobacco section became a bureau division on July 1, 1930. The development of a tobacco division involved no great change in activities, but was brought about primarily as recognition of an industry which ranked second in exports of agricultural raw products and seventh when compared with all other commodities exported.

In 1925 there were less than 50 active contacts using the services of the tobacco section; this number has increased to 804. Sixty per cent of the contacts being serviced by the division are actually engaged in the tobacco business and allied trades. The services rendered to its business contacts by the division during the fiscal year ended June 30, 1931, numbered 58,541. There was an increase of 290 per cent in the activities of the tobacco division last year over those of the tobacco section the year before.

The work of the division during the fiscal year became more and more a work of individual service, requiring a greater study of minute and technical details. There were involved the questions of new trade outlets, protection of old outlets, ways and means of overcoming competition from other tobacco-producing countries, potential buying power, and credits. Individual problems necessitated a large increase in the work of foreign consuls, commercial attachés, and trade commissioners; nevertheless, the thorough and cooperative manner in which these problems were handled enabled the tobacco division to serve its contacts more adequately.

A publication of special import issued during the year was United States Tobacco and Its Markets, which was well received by the industry.

Preparation of a manuscript, Four Hundred Years of Tobacco, was started during the year, and the division will issue this compilation of data within a short time. Other bulletins discussing significant subjects are in preparation.

SPECIALIZED TECHNICAL SERVICES TO BUSINESS

COMMERCIAL INTELLIGENCE DIVISION

Information centered in the division of commercial intelligence respecting merchants in Canada, Mexico, and the oversea countries has been made much use of by American foreign traders during the past 12 months; more so, in fact, than during any previous 12 months in the history of the division.

During the past year 60,000 new and revisions of old reports have been added to the World Trade Directory file, so that file now contains reports in detail on over 500,000 foreign firms located all over the world. The amount of supplemental information being received daily in the division from American banks, credit organizations, and exporters in this country is proof of the value that these various organizations and firms place on the service.

Requests received from bureau clients for detailed information on foreign firms, referred to as World Trade Directory reports, totaled during the past fiscal year 193,500, an increase of 20 per cent over the preceding fiscal period. Of these requests, well over 60 per cent were serviced out of the central file maintained in the division.

The trade-listing service of the division, one of its oldest functions, continues to grow. During the year many old lists were revised and 3,963 new ones compiled; 750,000 of these lists were distributed, all as the result of direct requests. This service of the division has developed to a point that listings are now available with respect to foreign distributors of any type of merchandise that can be exported.

The division continues to keep informed on changing conditions in each foreign market affecting the payment or nonpayment of dealers' obligations and presents this information in digested form each week in Commerce Reports.

It continues to report trimonthly to American banks and credit organizations on failures, insolvencies, bankruptcies, etc., affecting merchandise dealers all over the world. It reports to American business men, through the medium of the bureau's district and cooperative offices, the anticipated visits of foreign buyers to this country.

The division handled, during the past fiscal year, 7,677 Trade Opportunities received from the foreign markets, which were made available to the exporters of this country.

It is the reservoir of information respecting all reliable sources of credit information to enable our foreign traders to rate buyers as credit risks, and has recently completed a study of terms customary in buying respecting practically every commodity in every foreign country, data never having been assembled before in such completeness by any Government or private organization.

The consular officers of the Department of State who are contributing to the division's work by gathering data in the field are deserving of much praise for their accurate and painstaking investigations and reporting activities.

DIVISION OF COMMERCIAL LAWS

Inquiries addressed to the division of commercial laws increased more than 20 per cent during the past fiscal year, while the services rendered by the division increased more than 17 per cent.

The change in European financial and economic problems has been reflected in changing taxes, while the urgent need of funds has been indicated by renewed activity and enforcement of provisions which had fallen into desuetude and an increased effort to collect revenue from all possible sources. This renewed activity has led to a large volume of inquiries concerning the possibility of consignments, particularly in European countries, the volume growing so large that special studies were made by the European section of the division as to the protection afforded and restrictions imposed upon this manner of trading.

With the increased use of airplane and other speedy methods of transportation, the problems for the liability of common carriers assume a growing importance, and in Latin America specific studies were made on this problem. Other problems of particular importance in that area resulted in studies of consignments, new aspects of protesting bills of exchange, and new legislation with respect to powers of attorneys and installment sales, the latter in cooperation with the committee on foreign law and conflict of laws of the Bar Association of the City of New York.

The value of the trade-mark protection service has increased materially during the past year, regular service being given for an increased number of countries and greater accuracy in the work being obtained. This exceedingly valuable service is far from attaining its maximum value, for trade-mark piracy is present in all nations, while the present service covers with regularity only a few.

While the division's trade-adjustment work is not designed for cash results, the activities along these lines resulted in cash recoveries of approximately $80,000 and replacement of merchandise valued at $19,000. The far greater intangible results, the promotion of good will and the maintenance of American export reputation for the observance of ethical trade practices, can not be valued. Incidentally, American commerce was safeguarded by identifying those foreign firms with which American exporters can not safely deal. In this work the bureau has enjoyed the continued and efficient cooperation of the State Department, the Federal Trade Commission, the Department of Justice, the Post Office Department, and better-business bureaus and trade associations and organizations throughout the country.

The growing interest of American insurance in foreign markets, both directly and through reinsurance, and the growing nationalistic tendencies in foreign insurance legislation, as well as the greater recognition of the effect of labor legislation and social insurance enactments upon American establishments abroad, was indicated by an increase of more than 20 per cent in requests for information in these fields. Cooperation in insurance matters was extended to Government officials in Argentina, Colombia, Guatemala, the Netherlands, and New Zealand, and to departments of banking and insurance in 11 of the United States. Assistance was also rendered on specific problems to the War Department, Department of Agriculture, Department of Labor, and a number of independent Government agencies.

During the fiscal year just closed the division published 42 special circulars, 2 trade-promotion monographs, and 4 trade-information bulletins. The special circulars deal with restrictions imposed upon business throughout the entire field of commercial law and generally throughout the world. The bulletins covered specific problems in Argentina, Portugal, the Baltic States, and France, while the trade-promotion monographs dealt with problems arising in Peru and France.

DIVISION OF CORRESPONDENCE AND DISTRIBUTION

The division of correspondence and distribution is composed of two sections. The correspondence section routes incoming mail and reviews outgoing material. One of its principal functions is to coordinate the activities of the bureau's many units to the end that similar problems are given similar treatment. Incoming letters routed to the appropriate commodity or service division or other unit during the past fiscal year totaled 213,995, practically the same as in 1929–30. There were 274,818 outgoing letters reviewed, an increase of nearly 30,000 over the previous year. The division's own outgoing mail is second in volume among the divisions of the

bureau; during 1930–31 there were 17,500 letters and forms sent out in answer to specific requests.

A reduction in letter writing of the bureau was accomplished through the preparation of form letters to answer the most common questions asked the bureau.

The distribution section has supervision of the bureau's mailing lists, and it methodizes them to prevent duplication. The main list, of course, is the exporters' index, a classified record of American firms interested in export trade. That list has grown from 19,302 names in 1926 to 25,123 at the close of the past fiscal year.

EDITORIAL DIVISION

One result of the greatly increased use of illustrations in bureau publications was the quickly apparent need of a central file of photographs so that they would be readily available to any division requiring them. Such a file was established in the editorial division late in the fiscal year. Although it is not yet complete, the file has already demonstrated its usefulness.

It has been noted that the work of the bureau during 1930–31 placed far greater emphasis on domestic markets than ever before. This situation was reflected in the work of the editorial division. The influx of manuscripts from the new domestic commerce divisions made it necessary for several members of the division's personnel to become, almost overnight, familiar with market research, cost analysis, statistical and analytical technology, and the new terminology characteristic of such studies, in order that the results of the research be presented to the business community in usable form.

In addition to this great volume of new work, the regular publications of the bureau were prepared for publication, and about as many foreign-trade publications as in the previous year. In the latter, also, a change in character was noticeable. There was a lessening of purely trade reports and a tendency toward more permanent reports. Some of the titles were Guide to American Business in France; Coal Industry of the World; Industrial Machinery, 1930; and Handbook of Foreign Currency and Exchange.

This combination of increased activity and continuation without diminution of the old has greatly taxed the capacity of the division.

FINANCE AND INVESTMENT DIVISION

The financial difficulties of several foreign governments caused a sharp increase in the number of inquiries received in the finance and investment division with reference to foreign budgets, public debts, banking, currency, and exchange. The inquiries not only were far more numerous than in normal times but also called for more extended research. There was also a notable increase in the number of visits from executives of banks in search of data bearing on foreign securities held by their institutions and their clients.

Because of the increase in bank failures abroad the division had many more inquiries regarding the standing of banks and the handling of drafts. The sharp decline in Australian exchange and in the exchanges of practically all of the Latin American countries likewise gave rise to numerous inquiries relative to various aspects of foreign-trade financing.

The discussion of the silver question led to many inquiries, in answering which the bulletins and special articles prepared in the division were particularly useful.

Numerous requests were received for information covered in the balance of international payments, and much time was devoted to developing the sources of information for several of the more important phases of this annual study.

The mailing list for the division's regular circulars was greatly expanded, and more precise and complete data were included in press releases.

Of the eight bulletins issued, one was an exhaustive treatise on Japanese banking. Another important bulletin was that on American direct investments in foreign countries, which contains the results of the first census of foreign investments ever undertaken. The results were useful in preparing the division's section of the report to the Senate on branch-factory movement abroad and in answering the many inquiries received regarding the character and scope of our investments in individual countries.

FOREIGN CONSTRUCTION DIVISION

The foreign construction division was organized in February, 1931, coordinating the construction activities of the various divisions of the bureau. Its primary object is to increase American participation in foreign construction work. It acts as a clearing house for information on construction projects overseas. It aids in establishing contacts between foreign specifying officials, engineers, architects, and buyers and American contractors, engineers, manufacturers, and exporters.

Since its establishment the division has completely reorganized the Foreign Construction News bulletin to conform more nearly to standard construction and engineering practice in reporting actual construction projects, contracts awarded, and other pertinent information to assist the American reader in establishing contacts and increasing his activities with respect to foreign construction work.

Foreign Highway News, devoted to information on highway projects and developments, has also been modified so as to give names and addresses of oversea contractors, enabling American firms and interested parties to establish direct contact. The division has continued to collect and distribute statistics and other data on foreign highways. It has cooperated with the Bureau of Public Roads of the Department of Agriculture in carrying out the resolutions of the International Road Congress held in Washington last fall.

The division is distributing an informational fortnightly bulletin, giving details and progress reports on construction work previously announced in its confidential bulletin mentioned above. There is also an informational service to the foreign offices of the bureau issued about once a month, carrying information regarding engineering and construction innovations in the United States. Its objective is to help to increase the knowledge abroad of American methods and achievements.

Direct contact has been established with engineering firms now engaged on or interested in contracting for construction work abroad. Data are being assembled for the preparation of a summary report

of the activities of American construction companies overseas, for the purpose of affording foreign interested parties as complete a report as possible on the types of work American companies have completed and can undertake.

Standards.—The work of the standards section has also been included in the scope of activities of the new foreign construction division. Cooperation with the Bureau of Standards and nongovernmental agencies has been continued. Reports of activities of national standardizing bodies, both here and abroad, as well as of organizations other than national, engaged in the study, development, and promotion of standards of grades, types, and quality of commodities, standard specifications for commodities, and uniform safety codes—all have been received and distributed.

International fairs and expositions.—Under the jurisdiction of the division are also coordinated the bureau's activities in connection with international fairs and expositions. Considerable assistance was given the United States commissioners in connection with plans for participation by the Government in the International Colonial and Overseas Exposition which opened at Paris this spring. The foreign fairs section also contributed largely to the preliminary plans for the participation of the Government in The Century of Progress, Chicago world's fair of 1933.

As an experiment, the bureau, through the American commercial attaché at Berlin, established a trade informational office at the Leipzig Spring Trade Fair in March, 1931. The American consulate at Leipzig cooperated. Attendance at this fair was made up almost exclusively of buyers, dealers, merchants, and manufacturers. The experiment proved a success, and similar participation will be made at the 1932 spring fair.

International conferences.—The coordination of bureau and department activities in connection with international conferences continues to be under the direction of this division. In the case of some meetings this involves cooperation in the preparation of agenda, attendance at meetings, technical advice, and the like. In the case of others assistance is required only in selecting delegations and assembling material for the use of the delegates.

Some of the international meetings in which bureau representatives took part during the last half of 1930 and the first half of 1931 were:

Third International Congress for Applied Mechanics; Stockholm; August.
Pan American Reciprocal Trade Conference; Sacramento; September.
Sixth International Road Congress; Washington; October.
International Congress of Aerial Safety; Paris; December.
International Standards Association Meeting; Berlin; February.
Conseil Central de Tourisme International; Budapest; May.
International Parliamentary Congress of Commerce; Prague; May.
International Coffee Congress; Sao Paulo; May.
Eighteenth National Foreign Trade Convention; New York; May.
Sixth General Congress, International Chamber of Commerce; Washington; May.
Permanent International Commission for Road Congresses; Paris; June.
International Congress for Housing Service and City Planning; Berlin; June.
Sixth Congress of the International Association of Agriculture of Tropical Countries; Paris; June.

DIVISION OF FOREIGN TARIFFS

The increase in the number of inquiries received by the division of foreign tariffs during the past year, together with the large variety of problems that have been presented to the division for study, analysis, and advice, again emphasized the vital need to American business houses of a reliable source of information on foreign tariffs and trade regulations. This has been especially true following the number of changes and revisions that have taken place in the tariffs of important foreign countries in the last 12 months.

With the full cooperation of the State Department and of our own commercial attachés and trade commissioners, the division has been able to untangle a number of kinks in the exporting process and to temper the difficulties and technical points in various foreign tariffs and trade regulations in such a way as to afford the American exporters the most economical and least troublesome method of entry into foreign markets. It is difficult to estimate in dollars and cents just what the total of these savings is, since one of the division's principal functions is to forewarn and guide, as well as to help smooth out difficulties after importation has taken place, but they are considerable.

The urgency of foreign-tariff problems during the past year called for even closer relations than usual with the various trade associations. This has been necessary not only to facilitate the dissemination to their member companies of information regarding developments in foreign tariffs and trade-control measures but for the verification of trade rumors and for consultations on particular foreign situations.

The greatly renewed interest in finding export outlets for products of American manufacture has brought to the division a large number of inquiries for special tariff information on various products as an important part of studies of prospective markets.

Two additional studies were issued in the series of handbooks on foreign tariffs and import regulations on agricultural products, covering Canned Foods in the Western Hemisphere and Canned Foods in Asia, Africa, and Oceania. Manuscript is almost completed for the fifth in this series, which is to be a study of tariffs and trade-control measures on grains and grain products in the principal foreign markets, including agrarian Europe.

In connection with the sessions of the International Chamber of Commerce held in Washington last May, the division was called on for special work on subjects under discussion during the meetings.

One of the accomplishments of the division that attracted considerable comment was the publication in April of a very timely article on Foreign Tariffs and Trade Control Movements, 1930–31. The demand for copies of this article from business firms, universities, business schools, and students of foreign trade was so heavy as to necessitate a reprint.

DIVISION OF REGIONAL INFORMATION

Seldom has it been so important to keep American industry abreast of foreign economic trends as during the past year, considering the

abnormal situation prevailing in almost every part of the world. Latin America, Europe, the Far East, and Africa—all presented problems meriting careful study and warranting individual advice and, where necessary, special caution in the conduct of foreign business. This service of the division of regional information has embraced remote regions of the world as well as countries concerning which information on internal developments is more easily accessible. For instance, an extraordinary situation developed in Persia during the year, involving stringent Government regulations on foreign exchange, and the advice of the division was particularly sought after by American concerns with outstanding claims or prospective shippers to that country. A special section of the division has been devoted entirely to the Russian situation.

As a result of the growing interest in the branch-factory movement, the department was instructed by a Senate resolution to prepare a report on the subject. The division of regional information was entrusted with the task of preparing the part of the report dealing with the underlying economic factors, while the part contributed by the finance and investment division dealt with the statistical phase. The report was issued as Senate Document No. 258.

In connection with the preparation of the report, which involved considerable investigation in foreign countries as well as in the United States, an amount of valuable material on the subject has been collected and is being kept up to date. In addition to being used in answering current inquiries, it will serve as a basis for an annual survey of the branch-factory movement, which will become a regular feature similar to the review of the international cartel movement.

One of the most extensive publications prepared under the direction of the division is the Commercial Travelers' Guide to Latin America, and a complete revision of this handbook, made during the past year, is now in the hands of the printer. The growing interest in the commercial possibilities of the Near East has occasioned the preparation of a Commercial Travelers' Guide to North Africa and the Near East, the first of its kind dealing with that region, and it is hoped that it may be ready for publication toward the end of the calendar year.

A review of the organization and characteristics of the French market, submitted by a trade commissioner in Paris, was published under the title of Guide to American Business in France. The division has recently undertaken the preparation of a publication on European sales areas. Numerous pamphlets and articles in Commerce Reports have already been published covering the sales areas and marketing problems in individual countries. Many prominent export organizations have commented on the value of these surveys, some stating that they are indispensable for any firms doing business in the territories covered.

Trade information bulletins were published on Cuban Readjustment to Current Economic Forces, Spain: Resources, Industries, Trade, and Public Finance; and Australia as a Market for American Goods in 1931. Many special articles and regional reviews were prepared for Commerce Reports, representing original research in the division or based on reports of bureau and State Department field officers. The foreign cable summaries appearing under the headings

World's Commercial News in Brief and Monthly Cable and Radio Reviews proved of concrete service to business interests. The division also continued the distribution of the weekly Russian Economic Notes, Commercial Notes on Canada, and the monthly trade reports compiled in the far eastern field offices covering China, Japan, and southeastern Asia.

DIVISION OF STATISTICAL RESEARCH

Demands upon the statistical research division were greatly increased during the past year, the business depression engendering a generally greater and more searching inquiry and analysis of the rapidly changing conditions. Practically all of the work formerly performed by the statistical assistant to the Secretary is now being handled by this division. These increased services necessitated some reorganization and some important additions to the staff. A detailed and continuing study of business cycles was carried on, with special emphasis on current developments. Regular weekly surveys of employment and of business conditions, domestic and foreign, were established and maintained.

The Survey of Current Business was transferred from the Bureau of the Census at the beginning of the fiscal year. During the year intensive study has been given to the editorial make-up and statistical contents of the publication, as well as to a more timely printing schedule. Under the new plan adopted the Survey now consists of a monthly of 56 pages, containing approximately 2,000 alphabetically arranged series covering a 13-month period, which provide the basic statistics for the 25 pages of charts and interpretive text; an annual supplement, the 1931 issue of which gives monthly data on the same 2,000 series running back seven years; and a weekly supplement giving the weekly and monthly data made available during the week just closed. This threefold service is provided for the same price as the old Survey—$1.50 per year. The typographical set-up of the publication has been entirely changed and placed on a plane comparable with the most recent advances in commercial printing of business journals. The printing of the monthly issues has been placed on a 7-day schedule and the weekly supplement has been placed on a 3-day printing schedule. The circulation of the Survey has been given special study and an intensive circulation campaign is being put into effect.

Studies were made in the field of graphic presentation and a regular advisory service established. In addition to the regular statistical advisory and checking service for other divisions of the bureau, a greater volume of special inquiries of all kinds was taken care of during the year, many of these requiring considerable research, special compilation, and analysis. Several special studies were made for the American delegates to the International Chamber of Commerce convention.

The work of preparing the regular annual publications of the bureau, the two volumes of the Commerce Yearbook, in the preparation of which other divisions of the bureau cooperate, and the Statistical Abstract, was carried forward, many new features being added. The usual analyses of United States foreign trade quarterly and annually by fiscal and calendar years were made and published in

Commerce Reports and as trade information bulletins. A Handbook of Foreign Currency and Exchange was published and regular monthly statements of foreign exchange rates issued. The handbook is now in its third printing.

The geographic section was called upon to render an increasing number of technical geographic services to business interests. Twenty-eight reports were prepared for map publishers. A large number of requests were received for Geographic News, and issues are now being sent regularly to many business firms, as well as map publishers and professional geographers. Correct spelling of about 400 geographic names was determined for use in the decisions of the United States Geographic Board. Geographic material was prepared for the Commercial Travelers' Guide to Latin America; cooperation was extended in the writing of the text for the Sixth Report of the United States Geographic Board; and a geographic study was made of present and potential wheat-producing areas throughout the world.

In the past year the translation section has translated, from 16 foreign languages into English and from English into 4 foreign languages, a total of 5,500 typewritten pages, not only for the bureau but for practically all bureaus of the department. The larger pieces of work included French Merchant Marine, Cost Analysis and Price Fixing in the Retail Trade, Spanish Code of Procedure, and International Responsibility of the Nations. The section assisted other departments, the Chief Coordinator's office, and especially the Civil Service Commission, in planning competitive examination papers in 18 foreign languages and in rating the results.

DIVISION OF STATISTICS

The work of the division of statistics consists of compiling and preparing for publication the statistics relating to the foreign trade of the United States. Statements of imports and exports of merchandise, gold, and silver, of vessels entered and cleared by countries and customs districts, and other statistical data are published annually and monthly.

The annual volume Foreign Commerce and Navigation of the United States, covering the calendar year 1929, was issued in two volumes. The practice of issuing the Monthly Summary of Foreign Commerce in two parts has also been continued in order to expedite the issuance of the principal data for exports and imports.

An annual report on the principal articles exported from each State was compiled and published for the calendar year 1930. The publication of certain weekly reports was continued during the year. These reports showed the exports of principal grains and flour; exports of pork products from principal ports; imports of raw wool by classes into Boston, New York, and Philadelphia; imports of wheat from Canada; exports of gasoline; and exports of citrus fruits.

About 15 monthly statements, showing exports and imports of principal articles and groups of articles, are prepared from data compiled for the Monthly Summary of Foreign Commerce and are published before the Summary is sent to the printer. Special reports on imports of cotton cloth by specified trade designations and imports of wool cloth by kinds are also issued monthly. Special

monthly statements to the number of 253 are issued, showing exports and imports of certain commodities by countries and by customs districts. A nominal charge of $1 a year is made for these statements in order to stop the distribution to those who may be no longer interested in receiving them. However, more than 5,000 individuals and firms paid for the service during the past year, thus clearly indicating their interest and belief that the statements are of distinct value.

The statistical classification of imports into the United States, which went into effect on June 18, 1930, with the new tariff act, was revised and amended and a new edition issued which became effective January 1, 1931. Schedule B, statistical classification of exports, was also revised and extended and a new edition issued effective January 1, 1931.

In order to facilitate studies of the effects of the tariff act of 1930 by the United States Tariff Commission, other Government offices, and individuals, Table No. 9, Imports for Consumption, showing quantities, values, rates of duties, and duties collected by articles, was prepared in two parts. Part I covers the period from January 1 to June 17, 1930, under the tariff act of 1922, and Part II covers the period from June 18 to December 31, 1930, under the new law.

TRANSPORTATION DIVISION

Problems in transportation and communication were sharply amplified during the past year. Intensive interest in reducing consumer cost has centered around our distribution system. During the year the transportation division engaged in several fact-finding studies to develop basic data relating to the various forms of transportation.

A study on industrial traffic management was published. The widespread need for information on this important phase of distribution was amply illustrated by the sale of the publication, which approximated 20,000 copies. The Associated Traffic Clubs of America, which cooperated in securing the basic information from industries, purchased more than 10,000 copies for their members.

The inland waterway section, with the cooperation of the domestic commerce divisions, completed an economic survey of the Altamaha River system in Georgia. This study, based entirely on facts procured by field investigators from interested shippers, was undertaken at the request of the Board of Rivers and Harbors, War Department, and will be included in the Army Engineers' report to Congress, relative to improvements of the Altamaha River system. Plans were made by the War Department and the Department of Commerce for the inland waterway section to undertake the economic survey of the Calumet River-Sag Channel project.

In conjunction with the Bureau of Public Roads of the Department of Agriculture, a field survey of motor freight transportation was started in February. Motor freight hauling firms in every State were interviewed by the field representatives of the two bureaus. The purpose of this study is to develop facts of an economic character, such as radius of haul, relation of various items

of costs, efficiency of operation from the viewpoint of consistent loads and back hauls, etc., and information on road conditions in important trucking areas.

Advice to American exporters regarding packing and shipping continued to be an important phase of the division's activities. In the domestic shipping field the division cooperated with the railways and express companies in a campaign to reduce transit wastes. It is interesting to note that last year's loss and damage claims paid by the railways were lower than in any previous year since the records have been kept.

The foreign railway section, which in addition to its technical activities, carries on the commodity work of the division, continued its efforts to promote the sales of railway equipment in foreign countries. One specific result of its trade-promotion activities was the sale of $430,000 worth of rolling stock to the Brazilian railways. Although the past year was not a favorable period for this industry, the section's commercial service increased approximately 13 per cent over the previous year.

In its joint foreign port research work with the United States Shipping Board the division has collected information on over 300 foreign ports, which has been revised for the new directory of foreign bunkering stations. Additional information relative to charges against vessels calling for bunkers only has been added, and the directory, when published, will contain information of this nature on about 225 ports. Monographs covering 20 ports in Argentina, Uruguay, and Brazil were about 60 per cent completed and a monograph on the Baltic ports about 30 per cent completed at the end of the year.

As a result of the combined efforts of the cable coordinator and the cable section, savings effected in tolls on bureau telegraph and cable messages amounted to $10,000 during the year. This saving was effected by the joint use of air mails and by employment of strategic foreign offices of the bureau for the purpose of relaying messages to other bureau offices in close proximity. The communication section rendered service to the American communication companies and to the general public.

TYPE AND REGIONAL DISTRIBUTION OF COMMERCIAL SERVICES RENDERED

The following table shows the services rendered to American business by the bureau and its 34 district offices during the past fiscal year. The table divides them according to type and the geographical area to which the service pertained. Each service listed consists of a personal contact by visit, telephone or telegraph, or letter with an American business firm or individual.

Every year but one since the organization of the bureau there has been an increase in the number of services rendered. During the year just closed there was an increase of 9.2 per cent over the preceding year. This increase was greater, both numerically and proportionately, than was recorded in 1929–30 over 1928–29.

Class of services	Fiscal year ended June 30					
	1926	1927	1928	1929	1930	1931
Total services rendered [1]	1,973,524	2,421,563	2,770,773	3,342,118	3,631,558	3,965,591
COMMODITY						
Aeronautics trade	(2)	(2)	(2)	(2)	43,937	41,327
Agricultural implements	29,753	53,444	73,463	89,591	88,641	80,635
Automotive	228,727	214,806	236,060	251,392	283,065	297,815
Chemical	119,613	122,300	126,007	146,122	170,581	193,827
Electrical equipment	133,462	109,947	117,788	142,526	157,420	195,336
Foodstuffs	155,301	180,867	226,445	247,092	252,371	300,517
Hides and leather	16,858	26,300	28,200	36,122	29,122	25,930
Industrial machinery	117,200	90,937	94,709	139,304	176,375	173,628
Iron, steel, hardware	221,252	213,949	216,975	236,550	264,318	282,125
Lumber	91,393	118,472	112,450	128,782	145,263	193,081
Minerals	28,172	54,503	80,026	92,258	84,587	70,621
Motion pictures	(2)	(2)	(2)	(2)	31,379	33,289
Paper	11,785	21,861	27,326	34,970	32,693	33,275
Rubber	14,260	21,790	23,893	31,660	27,185	23,532
Shoe and leather manufactures	7,148	12,744	14,740	21,492	23,325	27,256
Specialties	185,667	134,637	149,748	189,597	210,216	226,589
Textiles	106,590	124,332	129,139	166,855	185,863	231,208
Tobacco	(3)	(3)	(3)	(3)	(3)	9,619
TECHNICAL						
Commercial intelligence: World Trade Directory reports [4]	(5)	(5)	(5)	26,393	65,220	100,602
Commercial laws	16,318	16,984	24,543	32,161	39,624	46,449
Finance and investment	20,578	27,743	37,304	43,732	46,341	69,027
Foreign construction	(3)	(3)	(3)	(3)	(3)	2,459
Foreign tariffs	30,031	43,160	66,962	89,732	109,287	137,402
Statistics (foreign trade)	50,749	37,874	54,166	77,367	114,766	133,053
Statistical research	(6)	(6)	(6)	(6)	48,060	78,048
Transportation	25,806	36,506	55,956	76,160	58,649	58,499
MISCELLANEOUS						
Commercial processes [7]	(6)	(6)	(6)	(6)	102,492	301,954
Unclassifiable	362,861	758,407	874,873	1,042,260	840,778	598,488
GEOGRAPHICAL CLASSIFICATION [8]						
Africa					64,556	99,468
Eastern Europe	40,390	94,165	97,631	114,523	52,118	
Europe					558,222	1,109,519
Far East	246,990	288,631	300,280	259,860	271,852	317,039
Latin America	288,649	576,292	703,542	803,155	866,270	906,645
Near East	42,718	99,758	100,613	111,970	45,489	
Western Europe	831,043	718,324	773,481	929,295	462,448	
United States (domestic commerce)	65,559	61,786	126,196	265,375	441,719	751,364
SPECIAL SERVICES						
Trade opportunities [9]	437,059	578,343	713,805	885,213	915,058	496,086
Trade lists (lists of foreign merchants) [10]	578,524	537,144	568,696	690,372	740,823	769,636
Special mimeographed circulars [11]	3,327,120	2,583,725	3,659,725	3,626,135	3,579,176	4,929,852

[1] Does not include inquiries handled by cooperative offices.
[2] Established 1929-30.
[3] Established 1930-31.
[4] Other commercial intelligence services merged with above commodity items. See also "Trade lists."
[5] Included in miscellaneous prior to 1928-29.
[6] Included in miscellaneous prior to 1929-30.
[7] Production, wholesaling, retailing—general distribution where no commodity is specified.
[8] The services distributed as to area to which they pertain are all included in the total, but many service could not be classified geographically. The bureau changed its classification of areas on Jan. 1, 1930.
[9] Included in total.
[10] Originated in commercial intelligence division; included in total.
[11] Not included in total.

The assistance rendered the bureau by the consular offices of the Department of State has become increasingly valuable in investigations of foreign market conditions. The program of coordination of activities in the foreign field has resulted in such an increase in efficiency that one bureau office abroad has been closed during the past fiscal year and another one will be closed before autumn.

Very truly yours,

FREDERICK M. FEIKER, *Director.*

BUREAU OF STANDARDS

DEPARTMENT OF COMMERCE,
BUREAU OF STANDARDS,
Washington, July 1, 1931.

The honorable the SECRETARY OF COMMERCE.

DEAR MR. SECRETARY: I submit herewith a brief report on the work of the Bureau of Standards during the fiscal year ended June 30, 1931. The various subjects are grouped under the appropriations provided by the Congress.

GENERAL ACTIVITIES

Organization.—Two additional sections, one dealing with testing and specifications and the other with waste-land products, were set up in the organic and fibrous materials division, and the staff engaged on the design and construction of the new hydraulic laboratory has been organized into a hydraulic laboratory section in the division of mechanics and sound. A section dealing with chemical and miscellaneous products has been added to the trade standards division.

The regular staff at the close of the fiscal year numbered 1,066 employees. With miscellaneous assignments the grand total was 1,171 persons, an increase of 10 as compared with last year. The turnover was 5 per cent, the lowest since the World War. In five of the bureau's divisions there was no turnover. There were 531 promotions and reclassifications to higher grades, and the average salary ($2,505) increased by $55.

Cooperation.—It is of interest to note that in spite of reduced industrial activities the number of research associates stationed at the bureau by trade and technical associations has not changed materially. As of June 30, there were 95 associates from 45 associations. as compared with 96 from 41 associations last year. The bureau has maintained the most cordial relations with all Government departments with which it deals as well as with hundreds of outside public and private organizations interested in its work.

Finances.—The congressional appropriations for the fiscal year were $3,647,971, including $350,000 for the hydraulic laboratory, $400,000 for land, $147,000 for two radio stations, $75,000 for remodeling the shop building, and $40,000 for a new track-scale test car—leaving $2,635,971 for operation, research, testing, and standardization, an increase of $129,225 over the previous year. There were transferred from other Government units $474,015, including reimbursements. The testing, research, and consulting work for other departments carried on bureau funds is very heavy and growing rapidly. Every effort was made to operate economically, and $102,000 was turned back to the Treasury.

Visiting committee.—The present personnel of the committee is: Dr. S. W. Stratton, Gano Dunn, John R. Freeman, Charles F. Kettering, and Charles L. Reese. The committe held one formal meet-

ing and individually visited the bureau several times. (This committee, and its annual visit of inspection to the bureau, were provided for by the act creating the Bureau of Standards.)

Hydraulic laboratory.—The design of this laboratory was begun in July, 1930, with the aid of an advisory committee, consisting of a number of prominent hydraulic engineers. The final design was adopted in January, 1931, and construction started on April 23. It is expected that the building will be completed about April 1, 1932.

The design provides for a building 285 feet long, 60 feet wide over two-thirds of its length, and 92 feet wide over the remainder. There will be three stories at one end and two stories at the other. The building will contain two large concrete supply basins from which water will be pumped through the flumes and other experimental apparatus to a concrete measuring basin from which it will be returned through channels to the supply basins. A maximum flow of 250 to 300 cubic feet per second will be possible in the main flume, which is the dominating piece of equipment with a cross section 12 feet square over a length of approximately 200 feet. A description of this laboratory appears in Civil Engineering for July, 1931.

International relations.—The International Committee on Weights and Measures met in April and approved, without change, the resolutions of its advisory committee recommending the adoption of a "black-body" radiator as the primary standard of light, and requested the national laboratories to give special study to the bureau's standard which operates at the freezing point of platinum. A resolution was adopted approving the use of 20° C. (68° F.) as the standard temperature for all industrial length-measuring instruments, gages, etc.

The international committee recommended that the national laboratories make observations with silver voltameters to determine anew the correct value for the international volt. To hasten agreement on this point, the bureau sent Doctor Vinal to Berlin to make the measurements jointly with the representatives of the German and British laboratories. Dr. F. Henning of the German laboratory spent two months at the bureau, working on methods of temperature measurement, and also devoting a great deal of attention to the new primary standard of light and the melting points of platinum, rhodium, and iridium. Doctors Dellinger, Dickinson, and Osborne attended the plenary session of the International Electrotechnical Commission at Stockholm, Doctor Dellinger as the official delegate of the Institute of Radio Engineers and Doctors Dickinson and Osborne in connection with standardization of requirements for prime movers in the generation of electric power. Doctor Wenner reported to the International Geodetic and Geophysical Union, also in Stockholm, on the development of seismometers and salinity meters at the bureau. Doctor Briggs represented the bureau at the International Congress of Applied Mechanics at Stockholm. Doctors Dellinger and McIlwraith took part in the second meeting of the International Technical Consulting Committee on Radio Communication at Copenhagen in May and June, 1931. Doctors Dellinger and Austin represented the bureau at the sessions of the International Scientific Radio Union which were held in Copenhagen at the same time.

The bureau has cooperated with other national laboratories, and particularly those of England, France, and Germany, in comparisons of standards of resistance, capacitance, and candlepower. The interlaboratory comparison of the thermoelectric portion of the international temperature scale has been completed and work on the optical part of the scale is under way.

Some correspondence has taken place on a proposed new unit of heat, continuing the discussion mentioned in the report for last year. The bureau has suggested that before adopting any unit based on the electrical units, there should be a definite understanding as to the values of the units to be employed. No decision has yet been reached.

Visitors.—The bureau has been honored by many distinguished visitors from all over the world, 25 countries being represented.

Weights and measures conference.—The twenty-fourth meeting of the National Conference on Weights and Measures was held under the auspices of the bureau on June 2 to 5, 1931. Important actions of the conference included the adoption of a code of regulations for penny-in-the-slot person-weighing scales; revision of the code of regulations for lubricating-oil bottles; and the adoption of a code for odometers. Subjects considered embraced testing equipment for large capacity scales, scales for determining wheel loads on motor trucks, inspection of postal scales, Federal regulation of baskets and hampers, quality labeling of canned goods, and many other matters.

Conference of State Utility Commission Engineers.—The ninth annual conference of State Utility Commission Engineers, held at the bureau on June 4 and 5, was attended by 25 engineers representing 16 States, the District of Columbia, and the Province of Ontario, Canada.

Other conferences.—Many other important conferences were held, including a two days' session, November 24 and 25, of chairmen of simplified practice project committees, attended by representatives of over 50 industries; the metallurgical advisory committees on May 19 and 20 with over 60 in attendance; several meetings of the underground pipe-corrosion group; conferences relating to trade standards, and many technical subjects.

Federal Fire Council.—This organization, with the Director of the Bureau of Standards as chairman, made up of representatives of Federal institutions and the District of Columbia, formed last year to function in advisory and informative capacity on matters relating to fire prevention and protection of Federal buildings, held four meetings during the year. Committee reports outlining the fire hazards present and the needed structural changes and fire protection equipment, were received and acted upon, covering the Senate side of the Capitol and the Senate Office Building, the buildings of the Smithsonian Institution, and those of the National Training School for Boys. Through cooperation with the National Fire Protection Association, surveys are being made by its engineers of Federal penal institutions and reports have been completed on the Atlanta Penitentiary, the Chillicothe Reformatory, and the Industrial Institution for Women at Alderson, W. Va. Fire hazard and safety surveys of the bureau's buildings and occupancy were made by local committees.

American Standards Association.—The bureau has continued its close cooperation with this association. The Director of the Bureau of Standards is a member of the board of directors, and two

members of the bureau's staff represent the Department of Commerce on the standard's council. The bureau is sponsor for 14 standardization projects and is represented on 73 sectional committees.

National Screw Thread Commission.—The National Screw Thread Commission, of which the director of the bureau is chairman, has continued its work on the standardization of screw threads. Connecting threads for gas cylinders and valves have received particular attention. In cooperation with the American Society of Mechanical Engineers, a survey was undertaken to determine the extent to which the commission's screw thread standards are being accepted and followed by industry. About 7,000 samples of bolts and nuts have been collected and are being measured at the bureau. Consideration has also been given to a possible revision of the class 4 fit (fine) in order to make this class of threaded work commercially feasible with the threading tools and gages now available.

American Gage Design Committee.—A report of the American Gage Design Committee, covering plain and thread plug and ring limit gages up to 4½ inches, was published in February. The committee has mapped out a standardization program for extending the size range up to 12 inches, and for covering snap gages and length snap gages over the same size range.

Federal Specifications Board.—This board, of which the Director of the Bureau of Standards is ex officio chairman, has promulgated its six hundred and ninety-sixth purchase specification, 210 this past year, including 165 revisions. A large part of the research and experimental work on which these specifications are based is performed in the bureau's laboatories, and the chairmanships of several of the board's technical committees are held by members of the bureau's staff.

Publicity, bureau reports, etc.—The number of papers published in the Bureau of Standards Journal of Research was 146. In addition, the Technical News Bulletin and Commercial Standards Monthly were issued each month. Forty-eight papers were published in the other series of the bureau, including simplified practice recommendations, building and housing, commercial standards, circulars, handbooks, and miscellaneous publications. The total, including 12 numbers of each of the periodicals, 146 reprints, and 48 publications in other series was, therefore, 230.

Approximately 170 papers were published in outside journals. Releases to the press totaled 299, including several feature articles. The fifth annual number of the Standards Yearbook was issued in March. In commenting on the distribution of Government publications the Public Printer referred to this yearbook as one of his "best sellers." Unusual demands have also been recorded in connection with the bureau's circular 383 on washing, cleaning, and polishing materials, building and housing publication No. 15 on care and repair of the house, and several others.

Exhibits.—The bureau participated in the exhibit of colonial products at Paris, the industrial exposition at Liege, Belgium, the commercial exhibition at Washington, and in the exhibit of testing apparatus and machines held by the American Society for Testing Materials at Chicago in June.

Medical officer.—The plan of stationing at the bureau a medical officer of the United States Public Health Service has worked out

most satisfactorily. Not only have emergency cases been promptly cared for, but the general health of the employees has been improved.

Testing.—Table 1 gives a summary of the bureau's test work for the past year. The total number of tests completed was 212,717, and the fee value $816,979.59. The corresponding figures for 1930 are 200,726 and $683,614.51.

TABLE 1.—*Numbers of test items, determinations, and fee value for tests completed during the fiscal year ended June 30, 1931*

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	811	1,061	480	2,352	3,803	$18,852.60
Electric batteries		2,371	60	2,431	4,924	12,879.50
Electric lamps and lighting equipment	192	3,149	651	3,992	4,129	[1] 26,845.59
Length-measuring devices	146	129	6	281	1,875	2,337.25
Gages and gage steels	1,283	736	395	2,414	9,509	2,255.00
Hæmacytometers. sieves, thermal expansion, etc	3,538	321	290	4,149	19,857	11,138.85
Weights and balances	3,319	6,204	583	10,106	21,837	7,288.65
Scales	4	1,228		1,232	38,060	58,778.50
Timepieces	364	4	63	431	4,437	1,301.50
Volumetric apparatus	8,872	5,512	359	14,743	32,116	10,151.05
Hydrometers	801	617	27	1,445	3,669	1,897.00
Density determinations, etc			258	258	329	447.00
Laboratory thermometers	2,744	1,128	606	4,478	18,318	9,823.60
Clinical thermometers	27,954	64,361		92,315	411,956	12,006.50
Pyrometers, calorimeters, etc	223	53	133	409	5,754	4,631.50
Insulating materials	101	56		157	131	1,080.00
Fire-resisting materials	11	47		58	76	5,785.00
Fuels and lubricants	194	1,488	377	2,059	9,489	18,687.00
Automotive equipment, etc	10	152		162	471	9,525.00
Airplane engines		31		31	238	51,500.00
Optical instruments and materials	606	502	251	1,359	5,352	7,200.25
Carbohydrates	1	1,918		1,919	2,873	2,850.00
Radioactive materials	2,463	236	1	2,700	1,064	8,115.00
Engineering instruments and appliances	101	1,220	126	1,447	1,634	24,195.00
Aeronautic instruments	87	899	13	999	3,480	10,084.50
Aerodynamic tests of models	1	12		13	13	100.00
Physical properties of engineering materials	52	2,107	146	2,305	5,436	13,059.00
Sound producing and measuring instruments	9	30		39	45	1,086.00
Making of special castings		41	117	158	929	1,390.76
Fusible boiler plugs		397		397	794	993.50
Metallographic examinations		955	98	1,053	3,154	4,946.54
Miscellaneous metallurgical tests		1,000	540	1,540	4,002	8,260.90
Pottery and chinaware		47	9	56	331	418.50
Glass		21	38	59	131	231.00
Refractories and heavy clay products		479	50	529	1,591	4,935.90
Cement, concreting materials, lime, etc	26	19,950	57	20,033	89,428	[2] 221,363.75
Stone and sand-lime brick		77	125	202	889	2,659.00
Miscellaneous ceramic materials		5,301	6,745	12,046	26,694	38,625.90
Rubber		1,606	18	1,624	11,440	36,931.50
Textiles	22	5,900	712	6,634	15,900	34,861.50
Paper	18	1,664	1,101	2,783	8,299	25,528.50
Leather	1	315	39	355	1,769	3,698.50
Paint, varnish, and bituminous materials	6	2,780	150	2,936	23,375	63,413.00
Chemical analysis of metals	4	482	127	613	2,324	9,839.50
Chemical tests of miscellaneous materials	9	886	14	909	3,563	10,547.00
Distribution of standard samples	6,332	171	3	6,506	90	14,433.50
Total	60,305	137,644	14,768	212,717	[3] 805,578	[3] 816,979.59

[1] Includes fee value of $7,918.59 for inspecting 2,971,048 incandescent lamps at various factories for other branches of the Government.

[2] Includes fee value of $54,802 for sampling, testing, and shipping 6,610,000 barrels of Portland cement and 50,130 barrels of masonry cement.

[3] Of these totals 235,062 determinations were for the public, fee value, $71,380.65; 534,257 determinations were for the Government departments and State institutions, fee value, $683,170.67; 36,259 determinations were for the bureau, fee value, $62,428.27. 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 ($710,000)

Maintenance and intercomparison of electrical units.—Three 1-ohm resistance standards of a new type developed by the bureau, measured in the national laboratories of Germany and England, showed that the units of resistance in use in Germany and in England are, respectively, 10 parts per million and 27 parts per million greater than the unit maintained by the bureau. An absolute method of resistance measurement has been under development in which the regulation of the speed of the driving motor is one of the major phases of the problem. This has been solved satisfactorily. Measurements of inductance on a porcelain-core inductance standard showed that 1 international ohm (Bureau of Standards) = 1.00051 absolute ohms.

Improvements and refinements have been made in the measurement and control of the temperature of the oil baths for the standard cells. Comparisons with several foreign national laboratories indicate that the bureau's value of the international volt is 20 microvolts below that of England and 60 microvolts above that of Germany. Experiments with the silver voltameter in which the bureau is cooperating through a representative now in Berlin, were begun in Germany in May and will be continued in England and France in the effort to reduce these discrepancies. Measurements with the Rosa-Dorsey-Miller current balance showed that 1 international ampere (Bureau of Standards) = 0.99997 absolute ampere.

Waidner-Burgess standard of light.—A proposal was submitted to the advisory committee on electricity of the International Committee on Weights and Measures that the reproducible light standard, developed last year at the bureau, be adopted as an international standard. Final action, however, was not taken at the 1931 meeting, as the other national laboratories had not yet had time to give the proposal sufficient study.

Freezing point of iridium and its use for light standard.—The freezing point of pure iridium has been determined by the crucible method in an electric induction furnace, resulting in a figure of 2,452° C., ±3°.

Preliminary observations of the brightness of a black body at the freezing point of iridium, following the same technique as that for the Waidner-Burgess light standard using platinum, have shown that the iridium freezing point can be so used, but with much more difficulty. However, it can be used conveniently for stepping up from carbon filament to tungsten filament lamps. The preliminary figure obtained for brightness of this standard is 1,250 candles per square centimeter in terms of the bureau's derived tungsten standards.

Maintenance of unit of candlepower.—Carbon-filament incandescent lamps were sent to the laboratories in five foreign countries and remeasured after their return. The units of candlepower as maintained in the United States and Great Britain are in close agreement, but the French unit seems to be about 1 per cent larger, and the unit, derived from measurements in Hefner candles, maintained in Germany, smaller by more than 1 per cent than the unit maintained at the bureau.

Magnetic testing and research.—A method for standardizing magnetic permeameters at high values of magnetizing force was developed. Investigations were carried out on the relation between magnetic properties and torsional strength of tool steel. Data to aid in the interpretation of the results of thermomagnetic analysis, with special reference to the effects of carbide particle size and the tempering of quenched steel, were obtained.

Ruling of line scales by interference methods.—Two meter scales and several shorter ones have been ruled, using light wave lengths to step off the intervals. One of the meter scales was subdivided into centimeters, the other into decimeters. The smaller scales were subdivided down as low as one-thousandth of an inch. All were free of any error requiring the use of a correction chart.

Recalibration of tape bench.—A check on the 5-meter intervals of the bureau's 50-meter bench standard, used in testing steel tapes, shows no change in excess of 0.1 millimeter from the result of the previous calibration made in 1922, the average change being less than 0.04 millimeter.

Graduation and calibration of precision circles.—The graduation and calibration of precision circles has shown that while the bureau's equipment is capable of graduating circles to an accuracy of two seconds or better, extreme care must be exercised in the mechanical and heat treatment of the circles, both before and after graduation, in order to maintain this accuracy.

Effects of wire diameter and of large openings of sieves upon sieving values.—Detailed measurements of large numbers of sieves have been made in connection with work on standard samples of abrasives.

Nickel-chromium alloy for weights.—The accuracy and behavior of high-precision weights made of an alloy of 80 per cent nickel and 20 per cent chromium, have been studied under a variety of conditions to which standards may be subjected in practice. Thus far the material seems to be of satisfactory constancy.

Variation of electroplated weights with humidity.—This investigation has been completed and the results are being prepared for publication.

Precision clock.—The precision free-pendulum clock mentioned in last year's report, especially adapted to use with the photoelectric cell, has been constructed and installed in the constant temperature clock room. It has been found to give seconds signals of a higher accuracy than those obtained from the Riefler clock.

Effect of temperature changes on rates of watches.—Preliminary results of a cooperative research indicate that watches equipped with uncut, monometallic balance and elinvar hairspring can be more accurately adjusted to compensate for temperature changes than can the ordinary watch equipped with cut, bimetallic balance and steel hairspring.

Cooperation with Horological Institute.—Cooperation with the Horological Institute of America in its efforts to improve the quality of service rendered by watch repairmen has continued.

Density of creosote oils.—In cooperation with the preservatives committee of the American Wood Preservers Association, volume correction tables have been prepared for creosote oils and creosote coal-tar solutions.

Density of chromic acid solutions.—The work on density of chromic acid solutions has been completed and the results published in the Journal of Research.

Ethyl alcohol tables.—A new series of ethyl alcohol density tables on the basis of percentage by volume was prepared at the request of the Association of Official Agricultural Chemists for publication in their "Methods of Analysis."

Orifice meter tests.—Data on several research projects involving orifice discharge coefficients and large capacity gas meters have been reviewed and correlated. Pulsating flows are now under consideration and the work done in this field is now being reviewed, preparatory to outlining the scope of the research which will be undertaken.

Absolute determination of gravity at Washington.—Work has been continued, but is not yet completed. One of three silica pendulums under construction is ready for preliminary work, and a Shortt clock has been installed and operated continuously for some months.

Spectroscopic investigations.—The arc and spark spectra and the Zeeman effect of zirconium, leading to a complete analysis of its spectral regularities, were obtained. Chlorine and bromine were specially excited by the electrodeless discharge to obtain the spectra of the singly and doubly ionized atoms. The hyperfine structure of certain lines of krypton and xenon was investigated by both the Fabry-Perot interferometer and the Lummer-Gehrcke Plate.

Laboratory intercomparison of methods for measuring ultra-violet radiation.—With the use of ultra-violet radiation for health purposes the demand for a reliable method of measuring this very difficult quantity has arisen. The bureau has cooperated with several other laboratories in measuring the ultra-violet output of the same samples of a specific type of lamp. Differences in the measurement by these laboratories appear to arise both from the inconstancy of the lamps and the inaccuracy of the measuring methods.

Photographic sensitometry.—The relation between photographic sensitivity and development time for several different types of emulsions has been investigated by using the three most common methods of measuring sensitivity. It is found that there is an optimum development time for obtaining maximum sensitivity.

Liquefaction of helium.—Helium was liquefied on April 3 for the first time in the United States, and with it a temperature of −271.3° C. (−456° F.) was attained, which is only 1.9° C.(3.4° F.) above the absolute zero of temperature.

Liquid nitrogen.—The construction of a new nitrogen liquefier was practically completed. The liquid nitrogen will be used for low-temperature work with flammable hydrocarbons, which would be dangerous if liquid air were used, because of the possibility of explosions.

Preparation of pure oxygen for use in international comparison of low-temperature thermometers.—This project required the design and construction of elaborate apparatus, and approximately two months of working time in its operation.

Specific heats at low temperatures.—In cooperation with the fixed nitrogen research laboratory of the Department of Agriculture, a project was undertaken for the determination of the specific heats of nitrogen organic compounds down to solid hydrogen temperatures,

and for the calculation of the entropies and free energies of the compounds from their specific heats. The construction of the apparatus was completed and the determination of the specific heat of primary amyl ammonium chloride is under way.

Oiliness of lubricating oils.—The frictional characteristics of a series of representative lubricating oils have been determined on the Grooved Specimen, Herschel, Kingsbury, and Timken oiliness machines. The results indicate that quantitative values obtained on each machine depend to a great extent upon the particular design and mode of operation. They indicate also that a more certain control of factors involved in oiliness tests is needed. This work was done in cooperation with the American Society of Mechanical Engineers.

Determination of the formula of a hydrocarbon.—A critical discussion of the measurements and calculations required in order to determine the molecular formula of any hydrocarbon containing not more than 100 carbon atoms has been published.

Standards of criteria for purity of hydrocarbons obtained from petroleum.—Satisfactory criteria for the purity and identification of hydrocarbons obtained from petroleum have been established.

Hydrocarbons from petroleum.—In cooperation with the American Petroleum Institute the investigation dealing with the determination of the composition of petroleum has been continued. The following hydrocarbons have been isolated and the quantities of each present in the petroleum have been determined: Ethane, propane, butane, cyclopentane, pentanes (2), benzene, methylcyclopentane, cyclohexane, *n*-hexane, 2, 3-dimethylbutane, 2-dimethylpentane, 3-methylpentane, toluene, methylcyclohexane, *n*-heptane, 2, 2-dimethylpentane, xylenes (mixture), *n*-octane, *n*-nonane.

Variation of transference number with concentration.—A new moving boundary method has been developed by means of which it is possible to measure the change in the transference number of a given electrolyte with its concentration in aqueous solution.

Chemical nature of rubber.—The investigation of pure rubber hydrocarbon has been continued in order to obtain photographic evidence of crystallinity, to make combustion analyses of extreme accuracy so as to detect any possible slight differences in composition, and to determine the molecular weight.

Painting plaster.—Information was collected and made available concerning the failure of paint on plaster, with suggestions as to possible causes of such failure and precautions necessary to reduce the probability of failure of the decorative coating.

Accelerated tests of asphalts.—In cooperation with the Asphalt Shingle and Roofing Institute, asphalt materials have been exposed to an accelerated cycle resembling that used on paint. The results obtained are similar to those produced by outdoor weathering.

Analytical reagent chemicals.—Sixty-three individual methods for the determination of various impurities in 18 reagent chemicals were critically studied, as the bureau's share in the preparation of specifications for reagent chemicals by the American Chemical Society. As a contribution to the study of the quality of analytical chemicals a report was prepared on the results of tests of all reagents bought by the bureau during a 2½-year period ended December, 1930.

Platinum metals.—Progress has been made in the second phase of the research on analytical methods for the metals of the platinum

group—methods of separation. Work on the separation of osmium was completed and published, together with the method for the determination of osmium, completed last year. A method for the strictly quantitative separation of iridium and rhodium from each other has been nearly completed.

Pure metals.—The physical properties of nickel of the highest attainable purity, 99.94 per cent with not over 0.001 per cent oxygen, have been determined and a report published. As part of the bureau's cooperation with the alloys-of-iron research committee of Engineering Foundation, the literature on pure iron has been critically reviewed and a monograph on the subject is in preparation. Laboratory work for preparing pure iron by precipitation and reduction methods is under way.

Thermal conductivity of metals.—A relatively simple comparison method for the determination of thermal conductivity of metals at elevated temperatures for commercial purposes has been developed. The thermal conductivity of pure metals and simple steels decreases with increase of temperature in the range from 50° to 550° C.; for high alloy steels, it increases. Transformation points in metals, as in nickel, can be readily located by thermal conductivity curves.

Magnetic change in iron.—The electronic changes underlying the magnetic change or A_2 transformation in iron are being studied by means of the β-ray spectrograph.

Elastic hysteresis research.—Theoretical study has been made and published of the vibration of elongated and short U-bars with special reference to their use in determining elastic hysteresis. In the experiments now in progress the results from tuning forks, U-bars, and straight bars have been compared, and show that the use of the elongated U-bar will be satisfactory, thus dispensing with the use of the expensive tuning fork.

Information circular on zinc.—A comprehensive review of the literature on zinc and its alloys has been completed. The results will form the basis of a circular similar to previous ones on copper, nickel, and aluminum.

Revision of Federal specification for industrial thermometers.—Federal Specifications Board Specification 472A was revised according to suggestions from the committee on thermometers and in cooperation with the Navy Department.

Federal specifications for rubber, textiles, paper, and leather.—During the year the committee on rubber products and packing materials, whose chairman is a member of the bureau, has prepared 46 specifications, and the bureau has assisted in the preparation of 40 specifications for textiles, 14 for paper, and 2 for leather.

Operation and maintenance of buildings.—The employees engaged in the maintenance and operation of the plant are divided into three groups, viz, power plant, guard, and janitorial groups. The duties of these groups, which include the operation and maintenance of the heat and power plant, the policing of the bureau's property, and the routine cleaning in the various buildings, were carried out, as heretofore.

Miscellaneous repairs and alterations.—This work included in addition to repairs to buildings, such interior alterations as were necessary to facilitate the work of the various laboratories. Extensive

alterations have been necessary in many buildings as a result of shifting all shops to the north building. Interior painting was continued and the excavation and fitting out of laboratory for optical work in the basement of the south building was completed.

Construction of instruments and apparatus.—The bureau's shops constructed most of the special instruments and apparatus, including blown-glass apparatus, required by the laboratories. In addition, cabinetwork, and the repair of furniture and woodwork required in the upkeep of buildings was taken care of, as heretofore. The necessary shop work was performed on specimens submitted for test, and standard steel and alloy samples were prepared. The alteration of the north building was completed in March, and most of the shops moved into this building, with a great increase in efficiency. Several new machine tools were installed and machines formerly belt driven were equipped with individual motor drives.

Additional research.—Of the 138 projects carried by this fund, only about 40 have been briefly described. A few others, which may be mentioned by title, are: Development of seismometers, electrical time-distribution systems, dimensional stability of invar, effect of temperature on rate of watches, fluidity of oils at low temperatures, establishment of color-temperature scale, methods of ultra-violet radiometry, microscope objectives, physical properties of paints, efficiency of gas ranges and water heaters, permeability of airship fabrics, and rubber core binders for foundry sand.

EQUIPMENT ($163,000)

Alteration and addition to north building.—A new third story was added to the north building, and many interior changes were made to accommodate the various instrument and machine shops which will be concentrated in this building.

Important purchases.—Important additions to the bureau's plant and laboratory facilities have been purchased under this fund. These include:

A new dead-weight testing machine for the engineering mechanics section, with a capacity of 10,000 pounds in increments of 100 pounds.

An interchangeable quartz prism spectrograph of high resolving power to be used by the spectroscopy section in the analysis and description of spectra in the ultra-violet.

A gas-fired steam boiler for supplying steam on a 24-hour basis to chemical baths.

Harmonic analyzer to be used in the analysis of radio waves in connection with experimental work on radio aids to air navigation.

A high-frequency radiotelephone set to be used in experiments involving communication between airplanes and the ground.

An improved saccharimeter for the polarimetry section to be used in determining the sugar content of solutions, especially in check analyses for the Customs Service.

A set of electrical filters is being constructed for the sound section and will be used in the analysis of noises. These were ordered during the fiscal year but will not be delivered for several months.

Two large metallographic microscopes have been added to the equipment of the section of optical metallurgy.

GENERAL EXPENSES ($64,000)

Maintenance of mechanical plant.—The usual maintenance work, such as replacement of piping, valves, and fittings has been carried on. Extensive piping changes have been made in the north building in converting it for the exclusive use of the shops.

Electrical construction and repair.—In addition to maintenance work, extensive new electrical installations have been made as a result of shifting some of the shops and laboratories.

Plumbing and pipe work.—Routine work on existing piping systems was performed, as well as much new work, made necessary by the many shifts in laboratories and in the refitting of the north building.

Library books.—The net number of volumes accessioned was 1,184, making the total number of accessioned volumes 36,403. Scientific and technical periodicals received number 1,275.

IMPROVEMENT AND CARE OF GROUNDS ($19,400)

Improvement of grounds.—Good progress has been maintained in the improvement of the grounds by grading, seeding, sodding, and the planting of trees and shrubs. The valley in the grounds fronting on Connecticut Avenue has been filled, preparatory to putting in a temporary road to the hydraulic laboratory. A new piece of permanent road and walk was completed between the chemistry and wind tunnel buildings. A storm and waste water sewer has been constructed along Van Ness Street.

TESTING STRUCTURAL MATERIALS ($320,000)

City planning and zoning.—Reports based on surveys of city planning and zoning in the United States have been issued and show widespread progress in the use of the recommendations of the advisory committee on this subject. The study of subdivision regulations has been continued. A pamphlet on the preparation of zoning ordinances, designed especially to aid smaller municipalities, has been completed and is being printed.

Home financing.—A detailed study of the experience of more than 5,000 purchasers of homes was completed, and the information obtained on the financing problems of these buyers is being studied in relation to data previously secured for issuance in a report.

Care and repair of the house.—A guide for householders who wish to keep their property in good condition was printed; 15,000 copies have been sold, and to meet new demands, 50,000 additional copies are being printed. The book has attracted much interest from the press, local merchandising houses, national trade associations, and educational institutions.

Cooperation with other agencies on building and housing problems.—Full or part time services of several members of the staff have been devoted to cooperative studies with the President's Conference on Home Building and Home Ownership, which finds it most helpful to have the assistance of members of the bureau's staff experienced in the study of problems of home ownership, construction, finance, city planning and zoning, and related subjects.

Absorption coefficients of acoustic materials.—Measurements have been made of the sound absorption coefficients of acoustic tile, acoustic plaster, and other materials designed to reduce the reverberation time of large rooms. Development of acoustic correctives has been so active that frequent revision of the tables showing the absorption coefficients has been necessary. These are now issued as letter circulars, three having been released during the year.

Protection for heating appliances.—Experiments on methods of preventing fires from household heating and cooking appliances were completed.

Tests of corrugated roofing.—Strength, absorption, heat, shock, and fire-spread tests were made, at the request of the Navy Department, of corrugated cement-asbestos and asphalt-covered steel boards.

Durability of concrete aggregates.—The average resistance of the commonly used concrete aggregates to the boiling and drying, freezing and thawing, sodium sulphate and sodium chloride tests was in the following order: Granite, trap, gravel, slag, limestone, and sandstone. Individual samples, however, varied greatly from this order, one sample of limestone being as resistant as the average granite. The absorption and porosity measurements were found to be of little value as criteria for judging the ability of the aggregate to withstand disintegration.

Cast stone.—Freezing and thawing tests on cast stone samples have been continued until the samples showed signs of disintegration. The resistance to freezing and thawing ranged from complete failure in 25 cycles to specimens that showed the first small signs of failure at 1,450 cycles. The average resistance to freezing of the samples made by the wet-cast process was equal to the average resistance of the specimens made by the dry-tamp process. The specimens formed by vibrating showed greater than the average resistance to freezing. A proposed Federal specification for cast stone has been drawn up and submitted to the industry for comment.

Waterproofing compounds.—The incorporation of 50 different waterproofing compounds in 1:3:6 concrete showed 16 per cent of the compounds to be effective in reducing the permeability of the concrete when it was subjected to a continuous water pressure of 20 pounds per square inch.

Fifty surface waterproofing materials coated on 1:2:4 concrete were less absorbent than uncoated concrete for the first few hours' immersion in water. The most efficient coatings after one year's immersion were asphalt emulsions and asphalt paints. Linseed oil, China wood oil, and varnish were the most efficient transparent coatings.

Aggregates for cinder concrete building units.—In cooperation with the National Building Units Corporation, samples of cinder aggregates from 60 plants are being tested to determine their grading, hardness, soundness, and concrete-making qualities.

Survey of the properties of common brick.—In cooperation with the Common Brick Manufacturers Association samples of bricks from 220 plants are being tested to determine their physical properties. Specification tests have been made on about 70 per cent of the samples.

Moisture penetration through brick and mortar.—Water under a head of from 0 to 8 inches penetrated more rapidly through bricks or mortar separately than through brick masonry specimens of the same size, a marked reduction in the rate of penetration occurring as the moisture passed from one material into the other.

Tests of Arlington Memorial Bridge.—Tests of one of the arch spans of the Arlington Memorial Bridge at Washington, D. C., have shown that the average temperature of the arch barrel has varied during two years from 28° to 85° F. The corresponding vertical crown movement was 1⅜ inches and the coefficient of expansion of the arch barrel was approximately 0.0000065 per degree Fahrenheit.

Durability and strength of bond between mortar and brick.—Masonry specimens of brick and mortar were subjected first to 50 freezings and thawings while saturated with water, and then to drying. The durability of the bond of the mortar to the bricks depended chiefly on the pressure on the mortar joints during exposure, the type of mortar used, and the moisure content of the bricks when set in the mortar.

Clay admixtures in concrete.—For concrete mixtures of the same consistency as determined by a penetration test, the substitution of clay either for 10 per cent of the volume of the cement or for 7½ per cent of the volume of the sand, in concretes containing about 5 cubic feet of cement per cubic yard of concrete, caused a slight increase in strength and a small decrease in the water permeability of the concrete.

Cement.—(1) It was found that the solubility of a cement in sugar solution was not a satisfactory index of its disintegration in sulphate solutions. (2) It has been found that CaO and $2CaO.SiO_2$ catalyze the decomposition of $3CaO.SiO_2$ into these products, and that the rate of decomposition is a maximum at 1,175° C. (3) The composition and melting points of the various anhydrous calcium borates have been determined. (4) A study of the reaction of water on the anhydrous calcium silicates has shown that $3CaO.SiO_2$ and beta $2CaO.SiO_2$ which have hydraulic properties give metastable solutions which subsequently precipitate out hydrated calcium silicates on approaching equilibrium. (5) The fields in which hydrated alumina hydrated tricalcium aluminate, hydrated tricalcium aluminate, and hydrated tetracalcium aluminate, respectively, are the solid phases in the system $CaO.Al_2O_3$—H_2O, have been determined.

Lime.—(1) Particle size distribution of hydrated lime: To calibrate the sedimentation apparatus, glass spherules have been separated into fractions wherein most of the material is within 2 microns of the average diameter. With this fractionated material check, sedimentation curves have been obtained with the automatic recording balance. (2) Soundness of finishing lime: The autoclave method of testing the soundness of lime has been found to be in agreement with correlating tests of the lime in plastered panels. (3) Federal specifications have been revised for quicklime and hydrated lime for structural purposes.

Gypsum.—(1) Volumetric changes of gypsum fiber concrete: It was found that the expansions of specimens of neat gypsum at the end of the fourteenth cycle of alternate drying and wetting ranged from 0.03 to 0.12 per cent of the original dry length, and 0.15 to 0.31

per cent for those specimens containing 12.5 per cent of wood chips. Specimens of the same materials showed much smaller changes when exposed alternately to air of low and high relative humidity. (2) Federal specifications have been revised for calcined gypsum, gypsum plaster, gypsum wall board, and gypsum plaster board.

Sand-lime brick.—It was found that both modulus of rupture and compressive strength are more indicative of the resistance of sand-lime brick to freezing and thawing than is total absorption. As a rule, sand-lime brick which had a rapid rate of absorption and high strength withstood freezing and thawing relatively satisfactorily. This statement is without reference to total absorption.

Building stone.—Forty-three samples of stone, most of which were limestone, were tested during the year in connection with the study of building stones. Weathering tests are in progress on 74 limestones, 21 sandstones, and 16 granites. Considerable attention has been given to studying the underlying causes involved in the destructive weathering of various types of stone.

Slate.—The investigation of the physical properties of slate from the important producing districts and the study of slate weathering are practically completed. This work has covered about 350 samples of new and old weathered slate. A test procedure for determining weathering characteristics has been developed which affords a means for selecting durable slate. In cooperation with the Federal Specifications Board a specification for roofing slate has been prepared.

Masonry cements.—An investigation of all the masonry cements on the market is under way. Workability, water-retaining capacity, strength, volume change, and specific gravity of the pastes and mortars are among the properties being studied.

Elastic cements.—Apparatus has been developed and a procedure established for the physical testing of pointing materials and slater's cements. During the year 153 samples have been tested for various departments of the Government. This has afforded a more satisfactory basis of acceptance for such materials as well as a means of enabling manufacturers to control their products.

Effects of variations in composition on vitreous enamels.—The fusibility of typical first-coat vitreous enamels is influenced more readily by changes in the boric oxide-sodium oxide ratio than by changes in the flint-feldspar ratio. The data obtained, when presented graphically, give a symmetrical figure. The fusibility has been measured in the following four ways, and the same general relationship to composition holds in all four cases: (*a*) Coarse deformation tests; (*b*) "fusion block" flow tests; (*c*) slumping temperature tests (by interferometer method); and (*d*) "button" tests (observing dimensions of the resulting "buttons" when cylinders of enamel powder are heated under standard conditions). Equipment has been assembled, and special means of preparing satisfactory specimens developed for measuring modulus of elasticity, coefficient of expansion, and tensile strength. Over 10,000 specimens have been prepared for these tests, and the measurements of expansivity with the interferometer have been nearly completed.

Cement reference laboratory.—The cement reference laboratory, a cooperative project of the Bureau of Standards and the American

Society for Testing Materials, continued its efforts to secure greater uniformity and improvement in cement testing. The field inspection of laboratories formed the greater part of the year's work, 122 laboratories having been visited. Requests for inspections during the second tour of the inspectors have been received from 196 laboratories.

Branch laboratories and inspection of cement.—The bureau's branch laboratories, maintained at Northampton, Pa., for the testing and inspection of cement; Denver, Colo., for the testing of cement and concreting materials; San Francisco, Calif., for testing cement and miscellaneous materials, together with the cement testing laboratory in Washington, have been engaged in testing service for Government purchasing agencies. During the year 2,311,000 barrels of cement, an increase of 42 per cent over last year, were sampled, and 1,830,000 barrels were shipped.

A 4,000,000-pound precision hydraulic compression machine, for testing concrete cylinders up to 3 feet in diameter, was installed at the Denver laboratory, and equipment for testing textiles, rubber, and leather was added to the branch in San Francisco.

Number of projects provided for.—In all, 43 research projects were authorized under this fund during the fiscal year. The general character of the work has been indicated in the preceding paragraphs.

TESTING MACHINES ($41,000)

Strength of welded joints in tubular members for aircraft.—In cooperation with the National Advisory Committee for Aeronautics and the Aeronautics Branch of the Department of Commerce, this investigation has been continued, using (1) a type of gusset-reinforced joint shown by previous tests to be most efficient, (2) joints heat-treated after welding, and (3) joints made from thin-walled tubing.

Fatigue of alclad.—Flexural fatigue tests were made on two groups of alclad sheets (approximately 0.1 inch thick) having core material of 17ST and 17ST special aluminum alloy. The maximum fiber stress (based on the total thickness of the sheet) for which longitudinal specimens withstood 100,000,000 cycles of stress without failure, was approximately 10,500 pounds per square inch for the alclad 17ST and 16,000 pounds per square inch for the 17ST core material. For the alclad 17ST special, the maximum fiber stress was about 12,800 pounds per square inch and 20,500 pounds per square inch for the core material. The tests on alclad specimens which had been subjected to 6, 12, and 18 months' exposure to salt spray, gave results which corresponded approximately to those on unexposed specimens. The tests on the core material, exposed for the same time, gave results corresponding to those obtained for alclad specimens.

Airship girders.—In cooperation with the Bureau of Aeronautics, Navy Department, an investigation is in progress on factors affecting the strength and rigidity of airship girders. Results of a series of compression tests show that the strength of the girders is dependent almost entirely upon the different types of critical instability. This, for some sizes and kinds of girders in the chord members, is torsion. In compression tests of short lengths of girders in which the twisting of the chord members alone was restrained, the strength of the girder was increased over 40 per cent. If practicable designs are

found for longitudinal members having high torsional rigidity, the strength of rigid airships can be considerably increased without increasing the weight.

Fixation of airplane struts.—In cooperation with the National Advisory Committee for Aeronautics and the Navy Department, a series of chrome-molybdenum steel tubular struts of different lengths has been tested in compression. The weight of aircraft structures may be reduced as a result, since the action of elastically restrained ends is now known more definitely.

Methods of locking screw threads.—Forty-one devices, representing all manufacturers who cared to participate, were tested, including nonproprietary devices, such as standard nuts, jam nuts, and slotted nuts with cotter pins.

Only about 22 per cent of the devices showed appreciable difference in static torque-tension characteristics from that of the coarse thread standard nut. In only one device was the screwing-off torque greater than the screwing-on torque at all stresses.

Federal specification for wire rope.—The specification for wire rope, No. 297, promulgated by the Federal Specifications Board in 1925, is now being revised to include some additional types of wire rope required by Government departments, and to bring the tables for strength into agreement with the values adopted recently by most manufacturers. Information on the care and use of wire rope will be included as a guide to users in obtaining satisfactory service from this important engineering product.

Other investigations.—Seven research projects were conducted under this fund, including studies of heat-treated bridge wire, measurements of hardness, and development of special devices to be used in testing machines.

INVESTIGATION OF FIRE-RESISTING PROPERTIES ($30,000)

Spontaneous heating and ignition of materials.—The research on susceptibility of jute to spontaneous heating and ignition, conducted in cooperation with the Bureau of Chemistry and Soils of the Department of Agriculture and a committee of the Marine Underwriters, was completed. As tested under a considerable range of conditions, no heating from microbial action in excess of 59° C. was obtained. Oxidizing oils, such as linseed oil and menhaden oil, applied to jute and to cotton fiber, induced heating culminating in ignition starting from initial temperatures in the range 30° to 50° C. No significant difference was noted between the results obtained with jute and with cotton.

Fire prevention and protection.—Activities in this field have been conducted mainly in conjunction with those of the Federal Fire Council and the National Fire Protection Association. Assistance was given in fire-hazard surveys of several Federal building groups and in the preparation of a committee report on protection of records from fire.

Fire tests of partitions.—Experimental work was initiated on a series of fire tests of interior partitions. Sixteen fire endurance or fire and water tests were made, the types tested including partitions built of magnesite-wood fiber blocks, fire-retardant treated wood, and of wood supports faced with gypsum plaster on plaster board.

Fire tests of welded steel floor construction.—Equipment for fire tests of a welded steel floor construction, conducted in cooperation with the American Institute of Steel Construction, was completed. This provides means for applying fire exposure from above as well as below on floor panels 13½ by 18 feet.

Additional research work.—Of the 15 research projects conducted under this fund, only 4 have been briefly described. Among the others were: Fire tests of brick walls, fire-protection devices, exit requirements, theater curtains, and standardization of fire-test procedure.

INVESTIGATION OF PUBLIC UTILITY STANDARDS ($107,290)

Electrical codes.—Manuscript was prepared for a new edition of the National Electrical Safety Code, containing revised tables of fiber stresses in wood poles as adopted by the American Standards Association. A report on low-voltage electrical accidents was prepared for the National Safety Council and printed in its transactions.

Measurement of high voltages and large currents.—Measurements made at about 100,000 volts with the large absolute electrometer indicated an agreement within 0.1 per cent with measurements made by means of a voltage transformer and an electrodynamic voltmeter. Refinements in the current-transformer testing equipment have materially increased the reliability and speed of this work. The upper limit for alternating-current tests now is 6,500 amperes at 60 cycles and 8,000 amperes at 25 cycles.

Surveys of telephone service in Government buildings.—Recommendations as to the telephone service in Federal buildings in 17 cities have been made in cooperation with the Office of the Supervising Architect, Treasury Department. Recommendations for telephone service have been made for the new buildings for the Department of Commerce, the Department of Agriculture, Public Health Service, and Federal Warehouse.

Standardization of gas service.—The bureau's representatives have served on six technical committees of the American Gas Association dealing with methods of test and performance of certain types of appliances, on the corrosion of materials used in the construction of gas appliances, and on other technical subjects. Assistance has been given in connection with the proposed revision of the gas-fitting regulations of the District of Columbia and the revision of the National Fire Protection Association relating to the same subject.

Testing and analysis of fuel gases.—Improvements have been made in the apparatus and methods employed for the analysis of gases and these have been incorporated into complete analytical units of superior accuracy and convenience which are now to be produced commercially. Commercial apparatus for the determination of carbon monoxide has been examined and tested, and a series of analyses of city gas was made for the Public Utilities Commission of the District of Columbia during the change from manufactured to mixtures of manufactured and natural gas.

Study of service standards for city gas supplies.—Existing State regulations for gas utilities have been completely summarized. Abstracting of the local service standards, both voluntary and required, of several hundred gas companies and municipalities has been par-

tially completed. A partial study has been made of the economics of the practice of "reforming" gases of high heating values to reduce their heating value before delivery. The improvement of existing standards for the control of heating value, meter testing, pressure control, the uniformity of the gas supplied, and service extensions have also received attention.

Corrosion of ferrous pipe materials.—About 1,000 specimens of ferrous pipe materials exposed to soil action for eight years have been examined and a report on the results prepared. Little difference in the rates of corrosion of the various materials is apparent, but the rates of corrosion differ greatly in different soils.

Corrosion of nonferrous pipe materials and coatings.—Results of the examination of about 2,000 specimens of nonferrous pipe materials exposed to soils four to six years indicate that copper and alloys high in copper resist the action of nearly all soils very well. Zinc coatings offer considerable resistance to soil action if sufficiently heavy and properly applied.

TESTING MISCELLANEOUS MATERIALS ($46,400)

Tests for Government departments.—An unusually large number of tests were made for Government departments on paints, varnishes, bituminous roofing and waterproofing materials, rubber goods, packings, inks, typewriter ribbons, carbon paper, textiles, boiler waters and compounds, detergents, chemicals, dental 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. A large quantity of mercury was purified for the use of the bureau's laboratories in research work.

Research.—Although this fund provides mainly for the testing of supplies purchased by the Government, four research projects were also carried on. These dealt with the turbidity method for determination of sulphur trioxide in Portland cement, paint and varnish test methods, varnish resins, and preparation of isoprene.

RADIO RESEARCH ($85,700)

Primary frequency standard.—The reliability of the equipment was increased. Checks made against the Arlington time signals, the Riefler and Shortt clocks of the bureau, and a quartz oscillator standard of the Bell Telephone Laboratories in New York by means of a wire transmission of an audio frequency, showed the standard to be reliable in continuous service to better than a part in a million.

Improvement of secondary frequency standards.—The performance of several temperature-controlled piezo oscillators was studied. They were found very satisfactory for controlling a transmitting set of exceptionally constant frequency. An improved piezo oscillator was constructed. Studies of the elasticity and vibration patterns of piezoelectric quartz were continued.

Standard frequency dissemination.—The bureau extended and improved its standard frequency service. The regular transmission of eight frequencies per month was continued. Beginning on Janu-

ary 6, these transmissions were augmented by highly accurate transmissions on 5,000 kilocycles, two hours in the afternoon and two hours at night on three days a month. These transmissions were controlled by a secondary standard piezo oscillator and maintained with an accuracy better than a part in a million. This work is a part of a program for eventually providing one or more frequencies continuously for check and control purposes.

Measurements of radio field intensity.—Field intensity measurements were made between Washington and Chicago on the 5,000-kilocycle standard frequency transmitter. Daytime field intensity measurements made on broadcast and airways phone transmissions indicated that existing formulas for field intensity are not reliable for overland paths at broadcast frequencies.

Improvements in radio measurement methods.—Improved methods of measuring the frequencies of transmitted radio waves with great precision were developed. New equipment for calibrating condensers, and an improved audio frequency oscillator incorporating a piezo oscillator have been designed and built.

Character and cause of variations of radio wave intensity and direction.—The technique of automatic recording of field intensities was developed and applied to observing the synchronized transmissions of certain broadcasting stations. The fading records taken on the Byrd Antarctic expedition were analyzed and prepared for publication. They showed that for frequencies of about 9,000 kilocycles per second over long paths the field intensity increased with the increase of darkness over the path; as the frequency increased to about 16,000 kilocycles per second the field intensity at first increased with increase of darkness until the path was about half dark and then decreased as the darkness increased.

Measurement of the height of the Kennelly-Heaviside layer.—Using the echo method, the height of the Kennelly-Heaviside layer was regularly recorded on frequencies from 590 to 10,000 kilocycles per second. Beginning in June, 1931, Kennelly-Heaviside layer height data were furnished to Science Service for publication in the Ursigrams each week. Transmitting and receiving apparatus for this work was developed so that pulses one ten-thousandth second in length can be transmitted and recorded. Plans for an automatic continuous recorder of Kennelly-Heaviside layer heights were developed.

Miscellaneous.—Eighteen projects were provided for under this fund. Among those not included in the preceding paragraphs may be mentioned: Improvement of radio standards of capacity, study of short waves, characteristics of receiving sets, and power factor of mica.

COLOR STANDARDIZATION ($15,800)

Transformation of color mixture data.—Methods for the determination of trilinear coordinates of color by visual photometric measurements have been improved; also methods of computing dominant wave length and colorimetric purity. Experimental data by Wright on equivalent color stimuli have been transformed so as to be more readily comparable with previous data. Methods of expressing tolerances in color specifications have been worked out.

Standardization of Lovibond glasses.—Methods of measurement have been improved, and 240 red glasses (making a total of 1,696 since January 1, 1928) were calibrated for use with 35 yellow, as in the vegetable-oil industry. Attention is now being given to standardization of the glasses in other connections urgently demanded.

Standard glass filters for testing spectrophotometers.—The rapidly increasing industrial use of spectrophotometers makes the establishment of this service a matter of urgent importance. Preparations have been made to issue filters of certified spectral transmission, which may be used in testing the performance of spectrophotometers.

Standards for railway signal glasses.—Although the bureau has made spectrophotometric tests of railway signal glasses for many years, the standard glasses established by the American Railway Association have heretofore been in private custody. These are now being transferred to the bureau.

Miscellaneous.—Fifteen research projects were conducted under this fund. In addition to those mentioned, the following may be listed: Life tests of lamps used for color-temperature determinations, measurement of diffuse reflection, color of daylight, spectral reflection of colored silk, and cooperation on new absolute standard of light.

INVESTIGATION OF CLAY PRODUCTS ($49,000)

Factors affecting the crazing of earthenware.—This investigation has been extended to include individual ceramic raw materials and a study of the effect of particle size. Data obtained indicate particle size to be an important factor, and the relative reaction of the various materials is shown by the following values: Feldspar, 2.5; lepidolite, 1.6; Cornwall stone, 1.4; clay, 0.4; flint, 0.05. Since it would be impracticable to replace feldspar entirely with one or more other fluxes, and since data on commercial ware show a fairly direct relation between porosity and moisture expansion, it would seem logical to correct susceptibility of earthenware to crazing by lowering the absorption.

Special low-fire, white-ware bodies.—With the development of means for heating electrically, the attention of the ceramic industry has been directed to this source of heat, and a study was undertaken to determine the possibilities of maturing white ware at, or below, 1,000° C. Wall tile, dry press plates, and cast ware were successfully matured and glazed at 950° C. The specimens produced withstood the autoclave test for resistance to crazing.

Feldspar and its effect on pottery bodies.—The final report has been published in the Journal of the American Ceramic Society.

Cutlery marking of chinaware.—A final report is in course of publication and will contain data of sufficient significance to justify the careful control, or elimination, of sulphur in decorating kiln atmospheres, thus aiding in the production of glazed ware which will not be susceptible to metal marking.

Changes in clay at high temperatures.—High temperature constitutional changes of clay, determined petrographically and by X rays, include complete dissociation of the clay molecule into silica and alumina at temperatures below 900° C. These combine in part at temperatures as low as 1,050° C. to form mullite.

Study of refractories.—Preliminary data obtained at 1,250° C. on 17 different brands of fire-clay brick show the modulus of elasticity to range from 70,000 to 300,000 pounds per square inch, and the modulus of rupture from 50 to 670 pounds per square inch. Bricks having either a very high alumina or silica content show much lower plastic deflections than do bricks having an approximately equal mixture. X-ray diffraction patterns established that the high rate of thermal expansion occurring in most fired clays between 100° and 200° C. is governed by the percentage of cristobalite present. For comparative purposes 23 brands of fire-clay brick were tested for resistance to thermal spalling according to the requirements of the two present standard methods and four modifications of these.

Resistance of metals to the abrasive action of plastic clay.—Tests have been made on 19 metals and alloys to determine their wear values. Also, the following fundamental factors have been determined: Relation between abrasion loss y and extrusion pressure x; relation between water content w of the clay and extrusion pressure; and relation between diameter d of the cylindrical orifice of the die and the extrusion pressure. These equations are, respectively: $\frac{y^n}{x}=c$; $wx^r=k$; and $d^2x=e$. In the order from highest to lowest resistance to abrasion the different types of metals and alloys tested are as follows: (1) Chrome-cobalt-tungsten compositions; (2) carbon-cobalt-chrome molybdenum steels; (3) vanadium steels; (4) high carbon steels; (5) cast irons; (6) rustless steels; (7) copper; (8) soft brass.

Problems relating to saggers.—Data obtained on the thermal expansion, moduli of elasticity and rupture, porosity, computed outer fiber strain, and plastic flow of specimen bars and small saggers prepared from each of 45 different sagger bodies fired at from one to three different temperatures indicate that it is very important to analyze the conditions of service under which saggers are to be used, because in most cases it is impossible to prepare from the usual run of clays sagger bodies which have properties ideally suited for longevity in all types of service.

Thermal dilation of special refractories from 20° to 1,800° C.—The linear thermal expansion was measured before and after heating to 1,700° C. or higher of California magnesite, silica brick, and Rhodesian, African, Grecian, and Indian chrome ores.

Properties of architectural terra cotta.—The investigation of terra cotta was continued in cooperation with the National Terra Cotta Society. Several buildings were inspected to determine what defects are developing in terra cotta in service. Laboratory research has continued for improving the quality by better manufacturing methods and to improve methods of setting the material in the building. Standard tests were developed and tentative specifications for terra cotta were prepared. It was found that certain glazes expand, because of the action of water, in a manner similar to bodies.

Columbus laboratory.—A study of the glassy bond present in fired ceramic materials has been started by preparing glasses likely to be formed by the constituents present and determining certain properties. Continued work on the properties of the colloidal separates of both English china clay and Ohio shales shows some general corre-

lations, but certain exceptions made necessary a study of the replaceable bases present in the clays, with promising results. In the temperature range 0° to 1,200° C. a number of commercially ground feldspars were found to give off relatively large volumes of water vapor, acid, and other gases. A number of new points were located in the multiple component system involved in the interaction of the slags and clay refractories of boiler settings.

Additional projects.—A total of 10 research projects were provided for by this fund. In addition to those mentioned, progress was made on the following: Physical properties of commercial English china clays, causes of failure of boiler refractories, and energy changes accompanying heating of clay materials.

STANDARDIZING MECHANICAL APPLIANCES ($51,321)

Testing of engineering instruments.—Approximately 1,300 instruments were calibrated, an increase of about 25 per cent over the previous year. In cooperation with the United States Geological Survey some experiments were made on meter equipment.

Postage metering and stamp vending devices.—The investigation and testing of mail metering and similar automatic devices for the Post Office Department have continued. There has been a rapid expansion in the development of machines of this nature, and the volume of work has shown a marked increase.

Fire extinguishing appliances and equipment.—Fire extinguishing appliances and systems have been tested for the Steamboat Inspection Service. Technical data on their effectiveness and reliability have been supplied. This work showed a marked increase in the past fiscal year.

Heating appliances for Government buildings.—A series of performance tests of radiator room temperature control valves for the new Commerce Department Building were made for the Office of the Supervising Architect of the Treasury Department. Performance tests of several types of radiator return line traps were also made for the same office.

Elevator safety interlocking devices.—Performance tests of elevator interlocking devices for compliance with the recently adopted "American Standard," have been extended to include additional devices. Results of these tests are used as the basis of approval by Government departments, certain State governments, and a group of casualty insurance companies.

Investigation of propeller fans.—A study was made of the effect of certain entrance conditions on the performance of 2-blade propeller fans and of the effect of increasing the number of blades from two to four. The results are described in the March, 1931, issue of the Journal of Research.

Plumbing investigations.—Investigations, partly financed by the plumbing industry, combining an experimental study of flow in pipes with field observations and measurements on plumbing systems in actual use, are in progress. A tower 100 feet high, surmounted by a 3,000-gallon tank and equipped with pumps and supply pipes delivering about 600 gallons per minute, has been erected and will provide equipment for measurements of capacity flow in sloping drains up to

6-inch diameters. A revision of those sections of the plumbing code relating to drainpipe sizes was completed in May, and the revised sections are being printed as a supplement to the report of the subcommittee, pending the completion of the present investigations.

INVESTIGATION OF OPTICAL AND OTHER TYPES OF GLASS ($27,300)

Production.—Thirty pots of optical glass, embracing five different kinds of glass, were melted. From these melts 37,955 blanks for optical elements, weighing 3,001 pounds, were made for the Navy Department.

Viscosity.—Viscosity measurements on six ordinary kinds of optical glass have been completed. Results show that the viscosity between 1,000° and 1,400° C. increases in the following order: Dense flint, medium flint, borosilicate crown, light barium crown, barium flint, ordinary crown.

Composition and physical properties of glass.—Relations between composition of certain soda-lime-silica glasses and their refractivities $(N-1)$ can be more accurately expressed by simple equations than by exponential equations. The best solution obtained is $(N-1)=aA+bB+cC$, in which A, B, and C are the percentages of silica, soda, and lime, respectively, in the glass and a, b, and c have the following values in the indicated silica ranges:

Silica range	a	b	c
50 to 59.5 per cent	0.004836	0.005491	0.007521
59.5 to 73.75 per cent	.004785	.005568	.007598
73.75 to 100 per cent	.004584	.006127	.007977

Specific volumes (V) of these glasses can be computed from $V=a_1A+b_1B+c_1C+d_1C^2$, A, B, and C having the same significance as above and the values of the constants are:

Silica range	a_1	b_1	c_1	d_1
50 to 59.4 per cent	0.0042520	0.0035370	0.0025667	0.0000061
59.4 to 66.3 per cent	.0043028	.0034628	.0025000	.0000040
66.3 to 74.9 per cent	.0043922	.0032872	.0023190	.0000025
74.9 to 100 per cent	.0045400	.0028460	.0017900	.0000194

Additional research.—In addition to the two research projects described in the preceding paragraph, eight other researches were conducted under this fund, including: Properties of special glasses, chemical analysis of glass, molding and annealing, and methods of hardening glass.

INVESTIGATION OF TEXTILES, ETC. ($60,900)

Fastness to light of dyed textiles.—In cooperation with the American Association of Textile Chemists and Colorists a series of standards was selected for the different degrees of fastness. The relative fastness to light of 1,197 cotton, wool, silk, and weighted silk dyings,

representing 366 dyestuffs, when exposed to sunlight in the standard "sun test" of the association, were tabulated and classified into 7 fastness classes.

Weighted silk.—An accelerated aging test for weighted silk was developed. There is good agreement between the effects of exposure of silk to a carbon arc light for a few hours under certain conditions of temperature and humidity and those of exposure to a north light for several months.

Standardization of knit underwear.—As the result of a general conference of manufacturers, distributors, and users, the standards for undergarments developed in cooperation with the Associated Knit Underwear Manufacturers of America were approved as a commercial standard. The consumer should now be able to purchase underwear of proper size and fit regardless of where it was made or the price paid for it.

Properties of knit fabrics.—To obtain basic information on the effect of variables on such properties of fabrics as air permeability, thermal transmission, coefficient of friction (slipperiness), and moisture permeability, comparative samples of knit underwear fabrics of about 100 different constructions were tested. The results are now being summarized and collated.

Special textile test methods.—A study of new apparatus for measuring the thermal transmission of fabrics shows that it is much simpler to construct and to operate than the earlier apparatus, requires a smaller sample for test, gives results more rapidly, and is compact and portable. The values agree with those obtained at other laboratories. An instrument was constructed by which thickness can be read directly for any pressure on the fabric from zero to a given maximum.

Cotton fabric for parachutes.—Parachutes made from cotton cloth woven at the bureau and tested at Lakehurst by the Bureau of Aeronautics of the Navy Department, functioned nearly as well as silk parachutes. Two 75-yard lengths of cotton parachute cloth have been woven in the bureau's mill and will be submitted to the Bureau of Aeronautics for further trial. A report on the work has been published by the National Advisory Committee for Aeronautics.

Mercerization of cotton for aeronautical purposes.—A mercerizing machine for studies under strictly controlled conditions was built. An experimental procedure was developed for studying the factors of tension during mercerization, time, temperature, and concentration of caustic.

Government papers.—In cooperative research on paper currency with the Bureau of Efficiency and Bureau of Engraving and Printing, papers were made from highly-purified wood fibers which complied with the currency paper specifications and which had satisfactory printing qualities. Paper-making trials of pulp from redeemed paper currency show that satisfactory paper pulp can be made from this material. The addition of phosphoric acid to the gum of postage stamps was found to improve the adhesion of stamps to the more resistant types of envelope papers.

Paper-testing methods.—Methods of measuring grease, water, and air resistance, and acidity of paper have been standardized for the Technical Association of the Pulp and Paper Industry. The

American Society for Testing Materials was assisted in the establishment of a standard procedure for determining the folding endurance of insulating papers. Progress was made in the study of hygrometry as related to paper testing.

Standardization of commercial paper products.—The printing quality of lithographic papers is being studied in cooperation with the Lithographic Technical Foundation. As misregister is the most important problem, the work has been confined mainly to plant and laboratory studies of effect of variable humidity and tension. Paper towels, insulating boards, and binders boards were also studied.

Paper-making materials and processes.—Coating tests of domestic caseins were made to assist the Bureau of Dairy Industry of the Department of Agriculture in finding more suitable grading standards. Assistance was also given the American Newspaper Publishers Association and the Government Printing Office in correlating the printing qualities of newsprints with their components.

Preservation of records.—An accelerated test, using heat, for determining permanence of Government writing papers classifies them in the same way as sunlight. In paper-making experiments with highly purified wood fibers, papers were produced which compared favorably in stability and strength with the Government permanent record and currency papers. Data were obtained on the relation of sizing materials and fiber beating treatment to the stability of the papers. A survey of documents in public libraries shows the chief external deteriorating influences to be acid pollution of the atmosphere, high temperature, variations in atmospheric humidity, light, and dust. Laboratory studies of effect of acid-polluted air and of light are in progress. Tests of old publications stored in libraries revealed the importance of purity of paper fibers if papers are to resist deteriorating influences. The support of these studies by the Carnegie Corporation and the Brown Co. was continued.

Scope of the work.—This fund provided for a total of 20 research projects. The field covered is indicated in the preceding paragraphs, the examples selected being typical.

SUGAR STANDARDIZATION ($95,000)

Preparation of crystalline ribose.—This sugar is of great importance in the study of the physiological processes of the human body, but its cost is so high that but little attention has been paid to it. The bureau has undertaken a study of ribose to reduce its cost and to obtain information on its physical and chemical behavior and its relation to other sugars. A quantity of pure sugar has been obtained and an improved method of preparation developed which has resulted in a materially lowered cost.

Oxidation of sugars.—A new process has been developed for the manufacture of sugar acids and their salts. When it is desired to produce a salt the sugar is electrolytically oxidized in the presence of a bromide and a base. The bromide is continuously regenerated; hence a small amount will facilitate the oxidation of a large quantity of sugar. Since the raw materials are cheap, the new process has considerable commercial possibility for the manufacture of calcium gluconate and similar products.

Tariff act of 1930.—Much time was devoted to the investigations requested by the Congress during the drafting of the tariff act of

1930. In this act a radical change was made in the method of assessing duty upon molasses. The component of chief value is the total amount of sugar, and the new act orders the collection of the revenue on the total number of pounds of such sugar. This procedure necessitates changes in methods employed. These methods have been perfected, and in collaboration with the Bureau of Customs the necessary revision of the customs regulations has been made.

Method of levulose manufacture.—Gratifying results have been obtained in experiments with the semifactory-scale plant for the production of hard refined levulose. Portions of the plant were operated on a considerable scale and data secured to redesign unsatisfactory equipment. Among the more important new pieces now completed and in operation are: Converter temperature control, automatic defecator control, calcium levulate crystal grower, carbonator, and filter assembly. A carload of artichoke tubers was furnished gratuitously to the bureau by the Alabama Power Co., Birmingham, Ala., and transported free of charge by the Southern Railway.

Other work.—Eighteen pieces of research were provided for under this fund, including, in addition to those already described, oxidation of sugars by bromine water, optical constants of sugar, determination of density of molasses, lime precipitation of levulose, and optical identification of sugars.

GAGE STANDARDIZATION ($50,000)

Certification of master gages.—The American Petroleum Institute's grand and regional master cable tool joint gages have been remeasured. Many of the ring gages were found to be outside of tolerances on lead of thread, and the American Petroleum Institute arranged for correction of the gages by the gage maker. Complete sets for two sizes of joints have been corrected and remeasured. The remaining nine sets will be corrected and recertified during the summer and fall.

Gages for interchangeable ground-glass joints.—The manufacturers of ground-glass joints replaced the original master plain taper gages with more accurate gages made in this country. These were checked and found to be satisfactory.

Cooperation with the National Physical Laboratory and the Physikalisch-Technische Reichsanstalt.—Foreign manufacturers of oilfield equipment are using A. P. I. standards to a large extent, and the American Petroleum Institute has appointed both the National Physical Laboratory of England and the Physikalisch-Technische Reichsanstalt of Germany as official testing agencies for A. P. I. gages made in Europe. This has led to considerable correspondence between the bureau and these laboratories with regard to interpretation of A. P. I. gage specifications and standardization of methods of test.

New facilities.—Equipment added includes 31 internal micrometers for measuring plain-ring gages, attachment for measuring tapers on pitch diameter of ring gages, and comparators for determining variations in roundness and straightness and for comparing gage blocks and plug gages with an error of only two or three millionths of an inch.

INVESTIGATION OF RAILROAD AND MINE SCALES AND CARS ($102,300)

Master track scale calibrations.—Eighteen of the nineteen master scales in service were visited and calibrated by direct application of standard test loads. Minor modifications or adjustments were made on 10 scales and all were left accurate within an "adjustment tolerance" corresponding to an allowable error limit of 0.01 per cent.

Railroad track scales.—A total of 1,030 scales were tested, the greatest number ever covered in one year. Of these 75.9 per cent were correct within the bureau's tolerance which allows a mean maximum weighing error equivalent to 0.20 per cent of the applied test-load values. The average maximum weighing error was 0.21 per cent or but 0.01 per cent more than the allowable error limit. These values, in comparison with the results for the preceding year, indicate a higher proportion of correct scales but a slightly greater average weighing error.

Track scales for weighing grain.—Tests were made of 97 track scales utilized at grain elevators and mills for weighing carload consignments of grain. Slightly more than half were correct within the special tolerance of 0.10 per cent. A survey has shown that approximately half these scales are incapable of continuous maintenance within the tolerance recommended for them by the Interstate Commerce Commission. (I. C. C. Docket 9009.)

Test-car calibrations.—At the master scale depot, Clearing Station, Chicago, railroad track-scale test-weight car calibrations were made for 13 different owning systems on 28 different cars. The total number of calibrations was 57. In addition, 23 track-scale test-weight cars owned by railroads and industries which do not have access to master scales were calibrated by direct comparison with standard weight test loads in the field.

Paint coatings for test weights.—A study of the durability and protective characteristics of various paints recommended for application to 50-pound test weights is under way. Results thus far indicate that the constancy of test-weight values is dependent more upon conditions of handling and transportation than upon the nature of the paint coating. Loss of weight usually results from abrasion and chipping of the metal.

Contacts with technical bodies.—The bureau cooperated with the National Scale Men's Association and the American Railway Association in drafting a code of specifications for track-scale test-weight cars. Two new projects on which the bureau will cooperate with the first-named organization are: Preparation of a code of rules for operation and maintenance of track-scale test-weight cars, and definition of what constitutes a proper test of a railroad track scale.

Mine scales.—Tests were made of 140 scales in the coal-mining sections of West Virginia, Maryland, Indiana, and Ohio. About 48 per cent were found correct within the allowable tolerance of 8 pounds per ton of applied test load. A conspicuous increase in the proportion of correct scales is indicated. Improvement is most pronounced in the States of Maryland and West Virginia.

Improvements in field equipment.—Testing outfit No. 1, in use since 1913, will be replaced by new equipment, strictly modern in all re-

spects and containing improved facilities for handling and maintenance of weight standards. Testing outfit No. 3, which for some time has been in poor mechanical condition, has been shopped for replacement of journal bearings. This is expected to improve its transportability and eliminate it as a real or apparent transportation hazard. The outfit has been in steady service since 1918.

Postal scales and weighing.—At the request of the Post Office Department, laboratory studies were made of the speed and accuracy of weighing postal matter, and numerous samples of scales intended for postal weighings were tested. Assistance was also given the Post Office Department in the development of purchase specifications for postal scales and in the training of a field personnel which will conduct acceptance tests on new scales and routine service tests on scales in use in post offices throughout the United States.

Cooperation with Government departments.—Frequent consultations have been held with representatives of Federal departments on weighing and measuring problems and equipment, and numerous weighing and measuring devices have been tested or examined for these agencies, both in Washington and at Clearing Station, Chicago.

Cooperation with the States.—Formal State conferences were attended in Illinois, Indiana (two), Maine, Massachusetts, New Jersey, New York, Ohio, and Pennsylvania. The preparation of a digest of weights and measures court decisions was continued.

METALLURGICAL RESEARCH ($61,000)

Aeration and submerged corrosion.—With low oxygen contents the rate of initial corrosion of iron increases as the oxygen increases. With a high oxygen content a reversal occurs, and the rate of corrosion decreases with increase of oxygen. The pH of the water affects the form of the curve. Slight but consistent differences were observed with different compositions of iron and steel.

Copper roofing materials.—In cooperation with the Copper and Brass Research Association a study of these materials is in progress. Emphasis has been placed on corrosion failures, such as soldered seams and pitting.

Copper-base ingot metals.—A study of typical copper-base casting alloys is being conducted in cooperation with the Non-Ferrous Ingot Metal Institute, with the object of classifying such alloys on the basis of properties and thus simplifying specifications. The method of pouring specimens is being studied.

Fluidity of liquid metals.—A method has been developed for determining in the foundry the fluidity of any molten metal when cast into a mold. The length of the spiral casting made under carefully controlled foundry conditions has been found to be the most practicable test and to give very valuable information on the effect of different casting variables such as pouring temperature, sand "temper," etc.

Shrinkage of molten metals.—A method has been developed for measuring the shrinkage of metals in casting, and in cooperation with the American Foundrymen's Association it has been applied to measurements of cast iron.

Fatigue of metals—effect of inclusions.—A comparative study of two methods for determining the endurance of metals—the rotary beam and the axial-loading methods—has been made. The results indicate that the latter is a more "searching" test for determining the true endurance properties of material, such as rail steel, which contains inclusions.

Bridge wire.—Laboratory tests of specimens of heat-treated carbon steel wire from failed bridge cables did not reveal any characteristics to arouse suspicion, either in structure or properties. A method has been developed for testing the entire wire in fatigue. The results of fatigue and other tests on the entire wire indicate that the surface characteristics contributed greatly to the "spontaneous" failure of the wire under load. Long-time tension tests to demonstrate this are under way. The effect of possible changes in the wire by aging after heat treatment is being studied by thermomagnetic analysis.

Fatigue of metals.—In studying the effect of surface conditions on the endurance properties of bridge wire it has been found that galvanizing by hot dipping consistently lowers the endurance limit of annealed or heat-treated carbon steel, while zinc coating by electroplating has the opposite effect.

Rail steel.—Transverse fissures appear to be an outgrowth of secondary brittleness. By retarding cooling of a rail, after rolling, secondary brittleness can be minimized. Impact tests at high temperatures have shown a parallelism between secondary brittleness and low impact strength.

Spark testing of steel.—A chart showing the spark characteristics of steels has been prepared.

Machinability of metals.—A report has been issued on the relation between composition, heat treatment, and the machinability of steel forgings.

Additional projects.—Sixteen pieces of research were conducted under this fund. Ones not mentioned above, include: Study of Preece test for zinc-coated wire, corrosion of nonferrous metals, durability of screen wire cloth, effect of excessive cold working of metals, and properties of platinum metals.

HIGH TEMPERATURE INVESTIGATION ($10,200)

Melting and pouring temperatures of gray iron impact specimens.—The pouring of 380 test bars in 14 foundries was supervised, and pouring temperatures measured in cooperation with the American Society for Testing Materials.

Effect of elevated temperatures on micas.—The effect of temperature on the properties of 19 different kinds of mica, 12 of foreign and 7 of domestic origin, was determined.

Thermoelectric properties of platinum-rhodium alloys.—The study of the thermoelectric properties of the platinum-rhodium alloys has been completed.

Miscellaneous.—Work was also done on the effect of atmosphere on the freezing point of silver and on the establishment of a scale of color temperature, based on the color of black bodies.

SOUND INVESTIGATION ($11,260)

Ultra-sonic waves.—A research on the speed of transmission of ultra-sonic waves through various solutions and suspensions has been carried out. A report of this investigation, which is in a rather new field, will be published in the Journal of Research.

Sound-proof partitions.—The investigation of wall and floor structures designed to prevent or minimize the passage of sound has been continued. Noises resulting from direct impact with the partition, such as the impact of uncushioned heels on a bare floor, are transmitted more readily than air-borne sounds, and a special study has been made of floor structures designed to minimize such sounds.

Other projects.—Six projects are carried by this fund. In addition to the two mentioned are: Acoustical properties of materials, acoustics of auditoriums, standardization of tuning forks and bars, and the photographic recording of sound.

INDUSTRIAL RESEARCH ($225,000)

Storage battery construction and operation.—Paste mixtures from special samples of oxides having coarse particle sizes have been studied. Bismuth as an alloy in the construction of grids for storage-battery plates has not been found satisfactory. Automatic testing equipment has been installed for testing storage batteries.

Bituminous pipe coatings.—Approximately 90 varieties of bituminous pipe coatings are under observation. Methods of measurement which are independent of the observer have been developed. Examinations of specimens indicate that a large percentage of the coatings as applied contain pinholes, absorb moisture, and have low electrical resistivity after a year's exposure to moist soil.

Cable design.—In cooperation with the United States Coast Guard, a special submarine cable using rubber of low dielectric constant was designed. Over the armor of the cable there is a rubber jacket having properties similar to the tread of automobile tires. About 10 miles of this cable has been constructed and laid from Miami to a neighboring lighthouse.

Properties of electrical insulating materials.—A series of 17 compounds containing sulphur from 0 to 32 per cent in steps of 2 per cent, with pure rubber hydrocarbon, has been studied. The dielectric constant and power factor were measured at temperatures ranging from −80° to +260° C. at six frequencies between 60 and 1,000,000 cycles per second.

Wind pressure on structures.—Papers on wind pressure on circular cylinders and chimneys, and on measurements on a model of a mill building have been published. A contract has been placed for the construction of a model of one of the tall buildings recently completed in New York City.

Orifice meter research.—The work of analyzing experimental data has been continued and two papers have been prepared. The first deals with the difference of behavior between liquids and gases, and the second with experiments on the metering of large volumes of air.

Lag of aircraft thermometers.—The experimental determination of the thermometric lag of the various types of thermometers now used for measuring air temperature in aircraft was completed. With proper allowance for design limitations the electric resistance thermometer has a smaller lag than the bimetal and liquid-filled types.

Transfer of heat by convection.—A fundamental study of the phenomenon of transfer of heat by convection was initiated, attention thus far having been directed toward measurements of temperature distribution in fluids in the immediate neighborhood of heated bodies. An optical interference method, which utilizes the change of index of refraction of fluids with temperature, is employed. Measurements have been made of the temperature distribution in air surrounding flat plates and heated cylinders of various sizes.

Thermal conductivity of insulating materials at ordinary temperature.—Investigation of the mechanism of heat flow in fibrous materials was completed and published in the Journal of Research. (R. P. 243.) Useful data on the effect of arrangement of fibers and density of packing on the thermal conductivity are presented in the paper.

Pressure-volume-temperature relation of oil-gas mixtures.—In cooperation with the American Petroleum Institute measurements have been made of the volume and density of the liquid phases and the density of the gas phases of three crude oil-gas mixtures at various pressures and temperatures. The pressure range covered was 1 to 200 atmospheres and the temperature range 30° to 90° C.

Compressibility and thermal expansion of petroleum oils.—The results of this investigation, which was conducted in cooperation with the American Petroleum Institute, were published in the November, 1930, issue of the Bureau of Standards Journal of Research.

Thermal properties of oils.—This investigation has been carried on in cooperation with the American Petroleum Institute. Values have been obtained for the specific heats of (1) gasolines from 30° to 120° C., (2) gas oils from 30° to 180° C., and (3) lubricating oils from 30° to 200° C., which substantiate equation 5, page 26, Miscellaneous Publication No. 97, and the equation for specific heat on page 151, International Critical Tables, Volume II.

Vapor pressure of carbon dioxide.—Previous measurements at temperatures down to −50° C. have been made at this bureau. The range of observations has been extended to −78° C. Observations below this temperature are not considered necessary since sufficiently accurate measurements have been made at other laboratories. All available data are being correlated.

Properties of organic liquids.—Using the methods and apparatus previously developed for measurements of thermal properties of water and steam, values were obtained for the heat content and latent heat of vaporization of methyl alcohol, ethyl alcohol, and benzene, in the range 40° to 110° C. The results have been published in the Journal of Research.

Heat of combustion of methyl alcohol.—With an improved type of calorimeter the heat of combustion of liquid methyl alcohol at 25° C. has been found to be 726.34± 0.20 int. kilojoules per mole. This new value is about 1½ per cent higher than the highest previously reported result and completely removes certain discrepancies occur-

ring in the thermodynamic data in connection with the process of synthesis of methyl alcohol.

Heat of ionization of water.—This has recently been recalculated and the best value on the basis of existing data is 57,370 absolute joules per mole at 18° C.

Cryoscopic constant of camphor.—Discordant values for this constant have been reported in the literature. A new calorimetric determination of this quantity from the latent heat of fusion of pure camphor has therefore been carried out.

Heat content of phosphorus pentoxide.—As a contribution to the thermal data required in connection with industrial processes for the manufacture of fertilizer from phosphate rock, a determination of the heat content of phosphorus pentoxide between room temperature and 800° C. has been carried out.

Phase equilibrium diagram for the system Cr_2O_3–Al_2O_3.—This diagram has been determined and is characterized by complete miscibility of the two components in the crystalline state.

Acid in leather.—Leather tanned with quebracho-wood extract was found more resistant to deterioration by sulphuric acid than leather tanned with chestnut-wood extract. The influence of the degree of tannage was slight. No significant difference was found in leathers containing sulphuric acid, and to which 0, 10, and 20 per cent of cod oil and tallow had been added after the acid treatment. The rate of deterioration is greater with higher relative humidity. Commercial leathers tanned chiefly with a blend of chestnut and quebracho gave results between those obtained for leathers tanned with each of the materials alone. Chemical methods for determining the hydrolysis of the hide substance by sulphuric acid in these leathers gave results which parallel the deterioration of the leather on aging. Preliminary experiments show that the addition of salts to leather containing sulphuric acid decreases the rate of deterioration, and the addition of saturated oxalic acid solutions causes slight deterioration after six months' aging.

Salt for curing skins.—Analyses of 30 samples of typical rock and evaporated salts used for curing hides and skins show the salts to have a high degree of purity. The data have been presented for reference use in problems of damaging stains on hides and skins.

Fur-seal skins.—The thickness, tensile strength, stretch, and tear resistance of fur-seal skins were determined to aid in developing standards of quality.

Stress-strain recorder for rubber.—A simple and effective apparatus has been constructed for recording the stress-strain curves of rubber both on extension and on retraction. The behavior of rubber may be followed through any desired number of cycles of stress at any desired speed or elongation.

Repeated stressing of rubber.—The manner in which the stress-strain curve of rubber changes under various circumstances of stressing and the mode and extent of recovery on resting have been measured.

Photoelastic analysis of stresses in rubber.—The photoelastic effect in rubber has been shown to be proportional to stress, as is known to be the case for more rigid materials. Stress distribution around models of pigment particles in transparent rubber is being investigated.

Thermal conductivity of metals.—A comparatively simple yet accurate method and apparatus for measuring thermal conductivity of metals up to 600° C. has been developed. Measurements have been made on a few pure metals and on a number of steels and other alloys, mostly of the heat-resisting type.

Thermal expansion of heat-resisting alloys.—The research on heat-resisting alloys has been completed, and forms a valuable contribution to the literature on these alloys which are now being used extensively where resistance to tarnish and weathering is demanded.

Heat-resisting alloys.—Cooperation with the joint research committee, American Society for Testing Materials, and American Society of Mechanical Engineers has been continued with emphasis on the structural changes at high temperatures. Embrittlement by carbide precipitation at high temperatures has been studied with reference to the magnitude of the stresses to which the materials are subjected.

High-temperature properties of metals.—As a basis of all commercial alloys for high-temperature service the "creep" characteristics of the Cr–Fe–Ni series have been studied. The effect of various alloying elements for stabilizing austenitic steels has been studied in cooperation with a manufacturer of such materials.

"*Gas content*" *of metals.*—Two reports were issued, one summarizing in detail the analytical method. In the experimental work emphasis has been placed on the determination of "gases" in steel deoxidized in a special manner and on "abnormal" steels for carburizing.

Solubility of gases in metals.—A report on the carbon-oxygen solubility product in liquid steel has been issued. The value, 0.0025, has been found for this product, and 0.011 for the carbon-ferrous oxide product. The lower results reported by another research laboratory have been shown to be in error.

Quenching of steel.—As quenching media for steels, intermediate between water and oil, sodium silicate solutions appear much superior to glycerin and other solutions used commercially.

Wear resistance of metals.—The behavior of heat-treated carbon steels under abrasive wear by sand and under combined sliding and rolling metal-to-metal wear has been studied. The effect of grain size of the metal on its wear resistance and the influence of the atmosphere surrounding the specimens are also being studied.

Wear resistance of chromium-plated gages.—The advantages of chromium plating on gages of a simple shape have been clearly shown by tests in a special gaging machine.

Bearing bronzes.—In cooperation with a manufacturer, the relation of the wear resistance of bearing bronzes to the temperature at which they were cast has been studied; likewise, the effect of iron as an impurity in such bronzes. The most detrimental of the common impurities appears to be antimony.

Journal-bearing performance.—In cooperation with the American Society of Mechanical Engineers, the distribution of hydrostatic pressure in the oil film of a journal bearing has been determined. Nine tests were made covering a fairly wide range of typical conditions of operation.

Efficiency of gears.—In cooperation with the American Electric Railway Engineering Association, the friction losses under various

conditions of operation have been determined for three types of street-car reduction gearing. These include a single reduction, double reduction, and worm gear.

Anodic treatment of aluminum.—A rapid method for determining the quality of the coating, produced on duralumin by the anodic process of oxidation has been developed. The usefulness of this treatment as a preliminary before painting or varnishing has been established.

Analysis of silver-plating solutions.—Detailed methods for the analysis of silver-plating baths, including the determination of impurities and of their effects on the methods for other constituents, have been developed.

Dimensional changes in the manufacture of electrotypes.—In cooperation with the International Association of Electrotypers, the conditions for producing electrotype plates of uniform dimensions were defined. This information is especially useful in color printing, where the corresponding plates must register accurately.

Crystallography of organic compounds.—The optical properties of crystalline organic compounds have been determined for use in later identifications by optical methods. A photomicrographic technique was developed for use, especially, at very low temperature. Chemical microscopical examinations of special materials were carried out. The optical constants, densities, solubilities, and inversion temperatures of the formates of the metals in Group II were determined.

Spectrochemical analysis.—Several hundred samples of materials were analyzed, a large part of which were iridium and rhodium sponges prepared by the bureau in an attempt to obtain these metals in a higher state of purity than ever before accomplished. The effectiveness of the various chemical methods used was tested by spectrographic analysis, leading to final products of almost spectroscopically pure metals. Entirely new descriptions of the emission spectra, both arc and spark, of krypton, lutecium, ytterbium, columbium, and rhenium were obtained; that of rhenium being entirely new and serving, through the spectral regularities found, to deduce the structure of this last element to be discovered.

Optical instruments.—By combining the principles of the military range finder and the microscope, an optical depth gage has been designed and constructed by which lengths in the direction of sight may be measured with high precision. A sample instrument following the same design has been built by an optical manufacturer for use in assembling the sound reproducing mechanism of a motion-picture projector.

Photographic emulsions.—In the investigation of the principal independent variables of "after ripening" (ripening after washing), the effects of temperature, bromide, and hydrogen ion concentrations were tested on emulsions made by neutral and ammonia formulas, with varying gelatin and iodide content at varying stages of ripening. Emulsions made with normal gelatin were compared with those made with deactivated gelatin and known nuclear sensitizers. The results support the chemical-reaction theory of ripening.

Atomic structure investigations.—It has been found that metals bombarded by electrons even at potentials as low as one or two volts

emit a continuous spectrum extending through the visible and ultraviolet region. Most metals give a nearly identical spectrum which is evidently analogous to the continuous X-ray spectrum. Silver gives in addition a selective band of radiation corresponding perhaps to characteristic X radiation. These results fill a conspicuous gap in our knowledge of radiation processes and the atomic structure of metals.

Identifications.—Unusually heavy demands for testing and advisory service in this work have delayed the research on standardization. The bureau has made 22 official tests and was able to dispose of 16 additional requests by preliminary examination. In a single case in which a defendant pleaded guilty to a charge of fraud in connection with a claim for refund on income taxes the Federal Government was saved over $150,000 in principal and interest, and thousands of dollars additional by avoiding the expense of trial of the defendant. The plea of guilty was a direct result of identification established by the bureau. Lectures were given before each of the five groups of students trained by the Department of Justice as special agents.

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:

TABLE 2.—*Research associates at the Bureau of Standards*

Assigned by—	Number	Specific project
Aluminum Co. of America, New Kensington, Pa.	1	Fatigue of alclad.
American Association of Textile Chemists and Colorists, Lowell, Mass.	2	Action of light on silk; determination of iso-electric point of wool; standards for fastness of dyed textiles; tests of waterproofed fabrics.
American Bureau of Welding, New York, N. Y.	1	Strength of welded joints.
American Electric Railway Engineering Association (Capital Traction Co., Washington, D. C.).	1	Lubrication and efficiency of transmission gears.
American Electroplaters Society, Chicago, Ill.	1	Protective coatings.
American Face Brick Association, Chicago, Ill.	1	Face brick absorption and transverse compression, efflorescence.
American Foundrymen's Association, Chicago, Ill.	1	Shrinkage in metals in casting.
American Gas Association, New York, N. Y.	2	Gas burner design; tests of proprietary pipe-line coatings and methods of identifying corrosive soils.
American Institute of Steel Construction, New York, N. Y.	2	Formed sheet steel floors; fire tests of welded steel floor construction.
American Petroleum Institute, New York, N. Y.	13	Engineering principles in pipe-line protection and tests of protective coatings; thermodynamic properties of petroleum hydrocarbons; chemical constituents of petroleum.
American Society of Mechanical Engineers, New York, N. Y.	8	Thermal properties of water; lubrication research.
American Society for Testing Materials, Philadelphia, Pa.	2	Research in cement; testing.
Asphalt Shingle and Roofing Institute, New York, N. Y.	2	Durability of felt fibers.
Associated Knit Underwear Manufactures of America, Utica, N. Y.	1	Standardization of underwear sizes; development of specifications; properties of knit underwear fabrics.
Atlas Lumnite Cement Co., New York, N. Y.	1	Research in cement; testing, etc.
Brown Co., Berlin, N. H.	2	Quality of purified wood fiber.
C. F. Brush Estate, Cleveland, Ohio	1	Spontaneous generation of heat.
The Bunting Brass & Bronze Co., Toledo, Ohio.	1	Properties of bearing bronzes.
Carbide & Carbon Chemical Co., New York, N. Y.	1	Thermal properties of liquids.
Cast Iron Pipe Research Association, Chicago, Ill.	1	Strength of corrosion products of cast iron, location of corrosive soils, and statistical study of corrosion data.

TABLE 2.—*Research associates at the Bureau of Standards*—Continued

Assigned by—	Number	Specific project
Clock Manufacturers Association of America, Philadelphia, Pa.	3	Lubrication of fine mechanisms.
Committee of Marine Underwriters, New York, N. Y.	1	Spontaneous heating and ignition of jute.
Common Brick Manufacturers Association, Cleveland, Ohio.	3	Strength of brick masonry; moisture transmission of brick walls.
Commonwealth Fund Fellowship, New York, N. Y.	1	Combustion in engine cylinder.
Copper and Brass Research Association, New New York, N. Y.	1	Corrosion of copper roofing materials.
Cooper, Hugh L., Co. (Inc.), New York, N. Y.	1	Use of clays in concrete mixtures.
Dardelet Threadlock Corporation, New York, N. Y.	3	Methods of locking screw threads.
Gypsum Association (in cooperation with Federal Fire Council, United States Gypsum Co., Henry Klein & Co., and N. W. Magnesite Co.), Chicago, Ill.	2	Fire prevention and protection.
Indiana Limestone Association, Bedford, Ind.	1	Study of physical properties of Bedford limestone.
Johns Manville (Inc.), Manville, N. J.	1	Heat transfer between solids and fluids.
The Midvale Co., Philadelphia, Pa.	1	Properties of steels at high temperatures.
National Association of Dyers and Cleaners, Silver Spring, Md.	2	Properties of dry cleaning solvents; absorption of liquids by fibrous materials.
National Association of Hosiery and Underwear Manufacturers, New York, N. Y.	2	Cause and prevention of defects in hosiery; development of specifications; analysis of hosiery manufacturers' problems.
National Building Units Association, Philadelphia, Pa.	1	Concrete building units.
National Research Council, Washington, D. C.	4	Absorption coefficients of acoustic materials; preservation of records; properties of volatile liquid fuels.
National Terra Cotta Society, New York, N. Y.	2	Investigation of architectural terra cotta.
Non-Ferrous Ingot Metal Institute, Chicago, Ill.	1	Properties of nonferrous ingot metals.
Portland Cement Association, Chicago, Ill.	5	Constitution and hardening of Portland cement.
Port of New York Authority, New York, N. Y.	1	Strength of bridge towers.
Radiological Research Institute, St. Louis, Mo.	1	X-ray investigations.
Society of Automotive Engineers, New York, N. Y. (in cooperation with National Automobile Chamber of Commerce and American Petroleum Institute).	15	Cooperative fuel research.
E. R. Squibb & Sons, New Brunswick, N. J.	2	Properties of gaseous mixtures.
Subcommittee on Research, Recommendations, and Interpretations for the Elevator Safety Code, New York, N. Y.	3	Elevator safeties and buffers.
Utilities Research Commission, Chicago, Ill.	3	Alternating current properties of insulating liquids; direct current properties of insulating liquids; preparation of pure hydrocarbons.

NOTE.—In several cases one individual represented two or more supporting organizations. The total number of research associates stationed at the bureau on June 30, 1931, was 95.

Other research projects.—A total of 103 projects were carried by this fund. Only a few of the most important have been described. Thermal expansion measurements have been made on a great variety of materials, steam turbine and internal combustion engine oils have been studied, the efficiency of steam and hot water radiators has been measured, and many investigations, not mentioned, have been made on rubber, leather, and other industrial materials.

STANDARDIZATION OF EQUIPMENT ($235,000)

Facilitating the use of specifications.—Lists of sources of supply of commodities guaranteed to comply with the requirements of Federal specifications have been compiled for the use of agencies making purchases out of Federal, State, county, and municipal tax moneys. During the year the number of lists has been increased

from 271 to 335, the number of requests for listings from 8,175 to 13,267, and the number of firms registered on the lists from 2,892 to 5,161. Eleven lists of willing-to-certify manufacturers of commodities guaranteed to comply with certain commercial standards have also been compiled. The number of these lists has been increased from 10 to 21, the number of willing-to-certify firms from 199 to 628, and the number of requests for listing from 233 to 689. The total number of requests for listings is 13,956, received from 5,789 firms.

Facilitating the marketing of specification-made goods.—Increasing interest has been shown by organized producers and consumers, and by individual manufacturers and purchasers, in the application of the self-identifying quality-guaranteeing labeling system. Manufacturers are now using or planning to use quality-guaranteeing labels, or their equivalent, for brooms, dental alloys, dry cells, fireproof safes, gypsum, ink (writing, colored, and indelible), library paste, lime, linoleum, lumber, paint, paper (correspondence, carbon, blue-print, and brown-print), pipe, Portland cement, rope, soap, textiles, and wall board.

Labels, many of them underwritten by trade associations, are also being used in connection with commodities complying with commercial standards for aromatic red-cedar closet linings; diamond core drill fittings; brass, steel, and wrought iron pipe nipples; feldspar; men's pajamas; plate-glass mirrors; red-cedar shingles; staple porcelain and vitreous plumbing fixtures, Stoddard solvent; and wall paper.

Labels are now in use to identify commodities complying with simplified practice recommendations for: Abrasives, binder's board, composition books, hard-fiber and soft-fiber twine, lumber, kraft sealing tape, metal lath, paper grocers' bags, school furniture colors, tile, tissue paper, and woven wire fencing.

Nearly 100 trade associations and similar groups are using labels to identify or guarantee commodities complying with their specifications, which are often identical or in complete harmony with Federal specifications, commercial standards, or simplified practice recommendations.

Encyclopedia of specifications.—The second volume in the encyclopedia of specifications series was published under the title Standards and Specifications for Nonmetallic Minerals and Their Products. It contains all nationally recognized standards, specifications, and simplifications within its scope, presented either in full or by means of abstracts, tabulations, or cross references. Methods of testing, incidental to the formulation of commodity specifications, are included and form an important part of the work.

Simplified practice recommendations.—Twenty new simplified practice recommendations were developed by general conferences, thus raising the total to 149, exclusive of one regional recommendation and one limitation of variety recommendation. Both of the latter, and 117 of the 149 simplified practice recommendations, have been approved and accepted by the industries affected. Twenty-five recommendations are in process of acceptance. Recommendations covering 115 commodities have been issued in printed form.

Revision and reaffirmation conference.—Their respective standing committees reviewed 38 existing simplified practice recommendations.

Of these, 32, or 84.2 per cent, were reaffirmed without change, and 6 were revised. During the previous year, 34 recommendations of the 39 reviewed, or 85.3 per cent, were reaffirmed.

Adherence to simplified practice recommendations.—Surveys were made of adherence in the production, distribution, and use of 13 simplified commodities. The acceptors reporting indicated that approximately 90 per cent of their volume conformed to the recommendations. Similar surveys in 1930 showed that the percentage of adherence for 25 commodities averaged approximately 87 per cent.

Preliminary conferences and variety surveys.—Twenty-nine preliminary conferences were held for 21 different industries. Surveys of existing diversification of product have been conducted by simplified practice committees appointed by 11 of these industries, and plans were started for similar activity by the other 10 groups.

Commercial standards.—There were 62 active projects in this field at the close of the fiscal year. Eleven general conferences were held covering: Cotton fabric tents; tarpaulins and covers; mopsticks; seats for water-closet bowls; colors for sanitary ware; red-cedar shingles; knit underwear (exclusive of rayon); circular flat-knit rayon underwear; bag, case, and strap leather; plywood; Fourdrinier wire cloth; and steel-bone plates. Announcements that the following 11 projects had received a satisfactory majority of acceptances were issued: Plate-glass mirrors; mopsticks; aromatic red-cedar closet lining; boys' blouses, waists, shirts, and junior shirts; wrought-iron pipe nipples (first revision); cotton fabric tents, tarpaulins, and covers; staple seats for water-closet bowls; colors for sanitary ware; cotton goods for rubber and pyroxylin coated automotive fabrics; red-cedar shingles; and knit underwear (exclusive of rayon).

Twelve commercial standards were issued in printed form following a satisfactory acceptance by the industry: Interchangeable ground-glass joints; staple vitreous china plumbing fixtures; standard screw threads; special screw threads; feldspar; plain and thread plug and ring gage blanks; builders' hardware (nontemplate); aromatic red-cedar closet lining; mopsticks; plate-glass mirrors; boys' blouses, waists, shirts, and junior shirts; and wrought-iron pipe nipples (first revision).

Safety codes.—Members of the staff have participated in the work of the safety code correlating committee and other committees of national scope. Revision of the safety code for elevators, dumbwaiters, and escalators was completed, and text prepared for an elevator inspector's handbook. Codes for mechanical refrigeration, window washing, and floor and wall openings were completed. A revision was undertaken of the code for lighting school buildings and the code for automobile brakes and brake testing. Work was continued on codes dealing with walkway surfaces; conveyors and conveying machinery; mechanical power transmission; and cranes, derricks, and hoists. Assistance was given State and city officials in the preparation of local regulations.

Building codes.—The report, Recommended Minimum Requirements for Fire Resistance in Buildings, involving research in a highly complex field, was completed and published. Revised working stresses for brick masonry, based largely on experimental work at the bureau, were issued. Work was continued on the proposed

recommendations for exit requirements, involving studies of flow of people on stairways, ramps, and in other locations.

Plumbing codes.—New recommendations for sizes of horizontal branches, house drains, and house sewers were prepared. They are expected to result, as they become incorporated in State and local codes, in substantial economies to owners of buildings. Additional work is under way.

Designing of optical systems.—New formulas and standardized methods are being developed for the designing of optical systems. This work includes the derivation of algebraic formulas for the geometric aberrations of the first, seventh, ninth, and eleventh orders, and direct algebraic methods by which the phase differences at the image point corresponding to the geometric aberrations, may be determined.

Number of projects.—Twenty-four distinct lines of work are financed from this appropriation. Several of these, such as simplified practice and commercial standards, are made up of a large number of projects, reference to which has been made in the preceding paragraphs. Other work covers specifications for dry cells, standardization of storage batteries, minimum requirements for lighting of buildings, etc.

STANDARD MATERIALS ($10,600)

Distribution of standard samples.—During the year 6,506 samples were distributed, having a sales value of approximately $14,433.50, and approximately $10,200 worth of standard samples were added to the salable samples on hand. These included ores, ceramic, and metallurgical products, and pure chemicals. The number of samples on hand at the close of the year was approximately 89,000, and their value was $222,412, representing 95 different materials.

INVESTIGATION OF RADIOACTIVE SUBSTANCES AND X RAYS ($31,500)

X-ray protection.—An X-ray safety code was formulated and published as Handbook No. 15. It deals with X-ray insulation of operating rooms; X-ray and electrical insulation of X-ray equipment; protective devices for patients and operatives; fire precautions, especially in the storage of, and types of photographic films used; periodical tests; resuscitation from electric shock; and general precautions as to personnel working conditions.

International X-ray standards.—The portable secondary standard X-ray ionization equipment was improved in design, thoroughly tested in the bureau's laboratory and then in another laboratory in this country, preparatory to a comparison with the national standards of Great Britain, Germany, and France, which is now under way. It is anticipated that for the first time like values of the Röntgen may be obtained by this equipment in the various countries, and that it may be adopted as standard equipment at the International X-ray Conference in Paris.

Radium testing.—Twenty-four hundred preparations of radium—more than double the number reported last year—totaling over 20,000 milligrams of the element, and fixing the sales value of about $1,500,000, were tested.

Other investigations.—This fund provided for nine investigations. In addition to those referred to in the preceding paragraphs, the following may be mentioned: Photographic registration of alpha-ray tracks; X-ray study of the iron atom; application of the Geiger counter to cosmic rays; X-ray emission from thin targets; X-ray scattering by materials similar to the human body; performance of X-ray equipment used for radiological purposes; and electrical conduction in gases.

UTILIZATION OF WASTE PRODUCTS FROM THE LAND ($52,700)

Paper from wheat straw.—The efforts on this project have been continued, but the results are not yet wholly satisfactory. Many different methods of cooking straw to make paper pulp have been tried, but it seems that either the reaction is not sufficiently severe, so that the pulp does not have the required degree of whiteness, or else it is too severe, so that the yield of pulp is below the economic limit.

Insulating board from cornstalks.—This project has passed the experimental stage and is now in commercial use. Semicommercial work is being continued to improve the method of production and to make the product more resistant to fire and water. A new type of forming machine has been designed and placed in operation.

Pressed board from cornstalks.—If the mat of fibers used in making insulating board is subjected to heavy pressure, the product is hard, dense, and strong, and can be used as a substitute for lumber. Laboratory studies to find the optimum pressure, time, and temperature, are nearing completion, and equipment for semicommercial production is being designed.

Maizolith from cornstalks.—Further experiments are under way to improve the method of manufacture, and particularly to find a better way to dry the maizolith.

Xylose from cottonseed hull bran.—After several tons of xylose were produced, the factory at Anniston, Ala., was closed. Samples of xylose were sent to many medical laboratories to ascertain its effect on the human system, but it will be at least a year before any definite recommendations can be made. The industrial utilization of xylose is being investigated, the first step being the production of xylonic and trioxyglutaric acids for use in tanning and dyeing.

Starch from sweetpotatoes.—A new station was opened at Alabama Polytechnic Institute, Auburn, Ala., in July, 1930, to investigate the sweet potato as a source of starch for the southern textile industry. However, there is no definite information on the kind of starch needed. The uses of starch in various textile mills have been studied, and laboratory tests developed to determine the suitability of the material.

Kraft paper from southern pine.—Another station was opened at the University of Alabama at Tuscaloosa, in September, 1930. Improvement in the efficiency of the process of manufacturing kraft paper from southern woods is the main object of the work. Analytical methods are being developed for identifying and measuring the amounts of sulphur compounds present in the various wastes.

Refining cottonseed oil.—A cheap yet effective method has been developed for refining cottonseed oil, which is so simple and inexpensive that it seems feasible for the small oil press, or even for the

home. The oil produced is edible, and some soap is formed as a by-product. An investigation of the extraction of oil from seeds has also been started.

Analytical methods.—The analytical methods used for routine purposes are not adequate for the type of research conducted under this fund. Better methods have, therefore, been developed. A quantitative method for estimating xylose in the presence of glucose has been published. Refinements of the usual methods of pH measurement for estimating xylonic acid in the presence of trioxyglutaric acid have also been worked out and published.

Additional projects.—This fund was used for 14 projects. While only a portion of them have been described, the general character of the work is indicated.

INVESTIGATION OF AUTOMOTIVE ENGINES ($50,000)

Vapor lock.—Temperature measurements in airplane fuel systems show that many airplanes now in service require gasoline with low vapor pressure to insure freedom from vapor lock. Results of laboratory experiments suggest improvements in fuel system design which would permit the use of better fuels. Similar work with automobiles points to improper design of fuel systems as the major cause of vapor lock. As a result of this investigation, extensive changes are being made in forthcoming models, which will go far to minimize vapor-lock troubles.

Antiknock characteristics of fuels.—The octane number detonation scale has been adopted as recommended practice by the Society of Automotive Engineers. Approval of the test engine, developed by the cooperative fuel-research steering committee, is expected to follow completion of final tests now in progress. Definite procedure for testing motor fuels has been tentatively adopted and will soon be given final form. The objectionable feature of automobile engine detonation is noise; that of aircraft engines is overheating and mechanical shock. Recognizing this difference, the bureau initiated cooperative research on methods of measuring detonation of aviation fuels. The first symposium on this subject indicated need for such research, the results obtained by different methods being quite diverse.

Combustion in an engine cylinder.—Theoretical and experimental studies of gaseous explosions in constant volume bombs have been made to aid in interpreting recent stroboscopic observations of flame movement and pressure development in an engine cylinder. Preliminary measurements indicate that the progress and character of the explosion in the engine may also be investigated by analysis of the infra-red radiation through fluorite windows in the cylinder head.

Phenomena of combustion.—Using the soap bubble as a constant-pressure bomb, the relation between explosion temperature and rate of transformation in homogeneous mixtures of explosive gases at constant pressure is being studied in cooperation with the National Advisory Committee for Aeronautics.

Gumming characteristics of gasoline.—An investigation is in progress to develop significant test methods for determining the gum content of gasolines and its tendency to increase under storage conditions.

Automobile brakes and brake testing.—The safety code for brakes and brake testing, for which the bureau and the American Automobile Association were joint sponsors, is to be revised in view of the widespread use of 4-wheel brakes. The personnel of the revised sectional committee for this project was approved June 4 by the council of the American Standards Association.

Additional projects.—Only a few of the 17 projects under this fund have been touched upon. Others include: Measurement or road performance of automobile engines, oxidation of carbon monoxide in the exhaust, automobile spring suspension systems, causes of vibration of motor vehicles, and improvement of headlights.

INVESTIGATION OF DENTAL MATERIALS ($10,000)

Cooperation with American Dental Association.—The research associates of the American Dental Association and members of the bureau have made personal contacts with about 3,000 members of the dental profession through lectures, conferences, etc., in 19 cities well distributed over the United States. Tests of material for the Government have been more satisfactory than in any previous year, less than 10 per cent of the material supplied having been rejected, as compared with 50 per cent last year. No change has been made in the specifications. Many dental schools are inaugurating programs for investigating the properties of alloys, etc., supplied for their use. Some of these schools have arranged for their teachers to visit the bureau, thus insuring the fullest utilization of data on methods of test, selection of materials, and other benefits.

TRANSFERRED FUNDS ($468,283)

Organizations and projects.—During the year funds were transferred from the following departments and independent establishments of the Federal Government, covering the projects listed:

Bureau of Engraving and Printing: Electrodeposition; currency paper and stamps.

Department of Commerce: Promotion of use of specifications; aids to air navigation; aeronautical engineering problems; aircraft engine testing; engineering research.

Department of the Interior: Concrete testing for Colorado River Dam.

National Advisory Committee for Aeronautics: Aerodynamics; aircraft power plants; mercerization of cotton; embrittlement of duralumin and steel tubing; identification of steels.

Navy Department: Airship girders; aircraft instruments; gas-cell fabrics; identification of steels; embrittlement of duralumin; aircraft engine ignition; effects of humidity on engine operation; storage batteries; optical glass.

Post Office Department: Characteristics of automotive vehicles for postal service.

Smithsonian Institution: Safeguarding dome of Museum of Natural History.

Treasury Department: Radio receiving sets for the Coast Guard.

War Department: Gumming of gasoline; geared superchargers; substitute for shellac; substitute for sole leather; nontin bearing metal; development of machine guns; radio receiving sets; experimental gages; bomb ballistics.

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 funds. The in-

vestigations supported wholly by transferred funds resulted in the following developments:

Air navigation facilities—radio.—In this field the bureau's attention was devoted particularly to radiobeacon systems, means for blind landing, and aircraft direction finders. Mention may be made of a transmitter for the simultaneous transmission of radiotelephone messages and visual type radiobeacon signals on the same radio frequency; refinements in the design and calibration of the vibrating reed indicator; a new course indicator which gives the beacon course indications on a zero-center, pointer-type instrument; a deviometer which permits a pilot to follow any chosen course within 15° on either side of the fixed beacon courses. Improvements in the system of blind-landing aids include: A combined instrument which indicates both lateral and vertical positions of the airplane as it lands; an improved marker beacon for defining the landing field boundary; a dual-control airplane equipped for blind flights on the system; a simplified aircraft direction finder giving visual indications; a symmetrical longitudinal T antenna for aircraft, having better mechanical and aerodynamic properties than the pole antenna. Work was begun on a radio system to aid in preventing collisions when flying under adverse visibility conditions.

Aviation lighting.—Photometric measurements and visibility tests have been made on 24 and 36 inch airway beacons, code beacons, boundary lights, traffic-control projectors, and flying lights. Tentative specifications for red and green glasses for use in beacons, boundary lights, and flying lights have been prepared. A traffic-control projector and a reflector, giving a desired light distribution for flying lights on airplanes, have been designed and constructed. Experiments on beacons flashing Morse code signals, and visibility tests on colors for aviation use are in progress.

Control surfaces of airplanes.—A wind-tunnel study of the hinge moments of ailerons at large angles of attack was completed with the cooperation of the Aeronautics Branch of the Department of Commerce and the National Advisory Committee for Aeronautics. The results are described in N. A. C. A. Technical Report No. 370. Measurements were also made of the yawing moments produced by several rudders at large angles of attack.

Measurement of turbulence.—In cooperation with the National Advisory Committee for Aeronautics, a study has been made of methods of reducing turbulence in wind tunnels, and the results published in N. A. C. A. Technical Report No. 392. The apparatus for measuring turbulence has been further improved by extending the frequency range, for which the response is uniform, to 4,000 cycles per second.

Reduction of noise in airplanes.—In cooperation with the Aeronautics Branch of the Department of Commerce, a set-up has been provided for the study of mufflers for airplane engines.

Crash-resistant tanks.—In cooperation with the Aeronautics Branch various methods for making airplane fuel tanks less susceptible to failure in accidents are being studied. A new, elastic, synthetic material for lining tanks offers some promise of success.

Type testing of commercial airplane engines.—Eleven radial engines, including 1 Diesel, 8 inverted in-line, 4 horizontal-opposed,

and 4 V-type engines, including a 12-cylinder inverted V, were tested at the Arlington laboratory for the Aeronautics Branch. Of the 27 engines received, 14 passed, 11 failed, and 2 were withdrawn. Eight of the engines which failed were of new types, and three had received one previous test each.

Effect of air humidity on engine performance.—Tests made for the Bureau of Aeronautics of the Navy Department show that power always decreases with increase in air humidity. Injection of water spray into the combustion chamber gives high antiknock action without loss of power when optimum timing of injection and spark advance is employed. Further research at high compression ratios is essential.

Aircraft instrument developments.—An improved fuel flow meter, an electric resistance thermometer, four cartridge-type maximum indicating accelerometers, two suspended head air-speed meters, an angle of attack indicator, an aircraft course protractor, and a supercharger pressure gauge were constructed for the Bureau of Aeronautics of the Navy Department. The construction and installation of the mooring force indicator for the airship *Los Angeles* was completed. An investigation of damping liquids for aircraft instruments was conducted for the National Advisory Committee for Aeronautics.

Accelerometer for study of earthquakes.—In cooperation with the Coast and Geodetic Survey an accelerometer is under development. It is intended, primarily, for obtaining records of ground movements from which the forces on buildings, located within an earthquake area, may be calculated.

Radio receiving sets for Coast Guard.—Six receiving sets submitted as bid samples to the Coast Guard were tested. Specifications were prepared for new, improved apparatus for determining precisely the electrical sensitivity, fidelity, and overload characteristics of receiving sets.

Corrosion of storage-battery plates.—A procedure for determining the acetic acid content of storage-battery electrolytes has been developed. Apparatus has been assembled for measuring the electrical resistance of storage-battery separators, and a series of measurements made. Apparatus has been developed for estimating the rate of corrosion by measuring the changes in electrical resistance of lead-antimony wires immersed in separator extract solutions.

High-frequency fatigue testing.—The series of high-frequency fatigue tests being made on light aluminum alloys, in cooperation with the National Advisory Committee for Aeronautics, is nearly completed. The results agree very well with those obtained by slower methods.

Prevention of embrittlement of sheet duralumin by atmospheric corrosion, and deterioration of magnesium alloys by corrosion.—The fourth year of the 5-year program of outdoor-exposure tests under three widely different climatic conditions has been completed. The bad effect of improper heat treatment on sheet duralumin and the relatively short life of most coatings have been established. Tests of the materials which so far appear to be satisfactory will be continued. Magnesium alloys exposed to the weather at the bureau still show good tensile properties after two years, although the coatings

soon lose their adherence. Tests in the typical marine atmosphere proved to be too severe for magnesium.

Distinguishing airplane steel tubing of different compositions.—A report was issued on several nondestructive tests for this purpose. The spark test was of very great value in the case of only two compositions. Attempts to develop a simple chemical "spot" test were fruitless, although a much more reliable and quicker analytical method for molybdenum than that now in use was developed.

Gas-cell fabrics for airships.—Several wholly synthetic materials have shown promise as possible substitutes for goldbeater's skin, but have not yet advanced to the production stage. Materials submitted by manufacturers were examined and technical advice given.

Bearing alloys.—A cooperative study with the War Department on bearing alloys containing little, if any, tin is in progress. The properties at elevated temperatures of the important lead-base bearing alloys have been determined, and observations are now being made on sample bearings in Army trucks. In the study of leaded bronzes particular emphasis is being placed on the use of addition elements for improving the dispersion of the lead in bronzes containing up to 50 per cent lead.

Substitute for shellac in food containers.—An investigation for the War Department, and in cooperation with manufacturers of tin cans used as food containers, developed the fact that shellac is not an important or necessary component of the so-called "lacquers" and "enamels" used on the inside of tin cans.

RECOMMENDATIONS

Patent policy.—There is need for the establishment of a uniform patent policy for the Government with respect to patents developed in the service. The patent policy of this bureau has always been that patentable devices developed by employees paid out of public funds belong to the public. The visiting committee, during the past three years, has given most careful consideration to this subject and strongly indorses the bureau's policy of public ownership of such patents. If this is thought by the administration to be desirable as a general policy, I believe this end can be attained by the President setting up through Executive order, as a condition of employment, such regulations as may be deemed necessary.

Increasing demands.—Although the past year has been one of lessened business activity, the demands for the bureau's services, both from the public and from the Government departments, have increased. This is reflected particularly in requests for tests of instruments and materials, which have been greater than in any previous year. It is to be expected, with returning prosperity, that these demands will increase at an accelerated rate; therefore it seems but reasonable to make the necessary provisions in personnel, facilities, and space that will be needed.

Building program.—As stated in previous reports, the most urgent need is a new administration building, at a cost of about $400,000. This would relieve about 40,000 square feet of space in laboratory buildings, badly needed for testing and experimental work, and would also make provision for adequately housing the nonlaboratory functions of the bureau, now scattered through the other buildings.

The second need is for a high-voltage laboratory of a size and type and with the equipment to take care of an increasingly important field of standardization, testing, and research, in which this Government is in arrears as compared with Great Britain, France, Germany, and Japan.

Other building needs, which have been presented under a 5-year program, include an enlarged low-temperature laboratory, a fire-resistance laboratory, and new buildings for mechanical engineering and for high-precision testing in weights and measures.

Although some provision has been made for increased space in the branch laboratories at San Francisco and Denver, to take care of Government testing, it is anticipated that increased demands from the Pacific coast for near-by service will render it desirable to provide facilities at San Francisco for public testing.

Very truly yours,

GEORGE K. BURGESS,
Director, Bureau of Standards.

BUREAU OF FISHERIES

DEPARTMENT OF COMMERCE,
BUREAU OF FISHERIES,
Washington, July 1, 1931.

The honorable the SECRETARY OF COMMERCE.

DEAR MR. SECRETARY: I have the honor to submit the following report of the operations of the Bureau of Fisheries during the fiscal year ended June 30, 1931.

The commercial fisheries of the United States and Alaska in the calendar year 1929 furnished employment to more than 191,000 persons, of whom 123,000 were fishermen and 64,000 were in the wholesale and manufacturing industries. The catch amounted to 3,567,000,000 pounds, returning to the fishermen $123,054,000. Commercial fishermen conduct their operations on the high seas, along the entire stretch of our extensive coast line, including Alaska, on the Great Lakes, and in interior waters.

Angling is followed in practically all waters capable of supporting fish life, and interest in this recreational pastime has tremendously increased. The Senate Special Committee on Conservation of Wild Life Resources estimates that there are 8,500,000 fishermen or anglers in the country and that the value of fishing tackle manufactured is approximately $25,000,000.

The national Bureau of Fisheries is concerned with the wise use of this great natural resource and its maintenance and extension without danger of exhaustion. The output of fish and eggs from its 88 stations and substations located in 35 States, Alaska, and the District of Columbia approximated 7,122,000,000 during the fiscal year ended June, 1931, and included marine, anadromous, and freshwater species of commercial importance, as well as the highly prized game fishes. The bureau supplied 119 cooperative nurseries with over 4,000,000 young fish, increased its own output of fingerling fish by 28 per cent, and salvaged more than 182,500,000 fish in the Mississippi River section. Dependence on it for fish for stocking purposes was greatly increased because of the ruinous drought of the preceding season, in which many streams completely dried up. Added fish-cultural facilities provided for under the 5-year construction and maintenance program (act approved May 21, 1930) are being established as rapidly as possible.

The bureau's program of biological research included studies of 30 important food and game fishes, expansion of its program of research in the fields of experimental fish culture and oyster farming, and direct aids to the fishermen in forecasting the abundance of certain species, in effecting means for lessening the destruction of immature and undersized fish, and in determining what restrictions were needed to conserve the supply. The completion of a modern laboratory at Seattle, Wash., provides much needed facilities for the

Pacific coast biological staff of the bureau as well as for certain of its other personnel and the staff of the International Halibut Commission.

In the field of animal nutrition the bureau, in cooperation with other agencies, has been enabled to make noteworthy and timely contributions which have demonstrated the richness of domestic fish oils in vitamins A and D, thus extending their use in animal feeding. The relative feeding value of fish meals produced by the different processes of manufacture has been indicated, and the trade shown means for improving their manufacturing methods and eliminating waste. The assistance given has been especially timely because of the depressed fats, oils, and feeds markets and has resulted both to the advantage of the fish-reduction industry in increasing the demand for domestic products and to agriculture in making these products rich in certain factors available at lower cost. To meet the growing demands for investigations in this field, the bureau has been compelled to establish a nutrition laboratory in Washington, D. C., which is now in operation. There has also been set up a temporary fishery products laboratory at Gloucester, Mass., at which point important technological studies are being continued. In the collection of annual statistics of the catch the bureau was able to cover all sections except for certain fisheries of the Mississippi River.

Alaska fishery laws and regulations for the conservation of its fisheries have been executed vigorously in an effort to assure the maintenance of this great resource. The seal herd breeding on the Pribilof Islands has been built up until it now numbers considerably in excess of 1,000,000 animals, and the current season's killing of surplus males is expected to approximate 50,000.

With the appropriation of the sum of $6,075, available March 1, 1931, for the balance of the fiscal year for the enforcement of the law regulating the interstate transportation of black bass, as amended and approved July 2, 1930, the bureau proceeded with all possible promptness to organize a new division to perform the functions imposed by the law.

In the calendar year 1930 the fish-canning industry—the most important process of manufacture—packed 576,685,000 pounds, valued at $82,858,000. In excess of 80,000,000 pounds of fresh fish, valued at $12,500,000, was prepared for the market by the packaged fresh-fish trade, and 139,297,000 pounds of fish were frozen. Secondary fish products to the value of $23,721,000 were produced by the by-products industries. During the previous year the production of cured fish amounted to more than 110,000,000 pounds, valued at $17,500,000, and in 1930 imports of fishery products for consumption were valued at $50,830,000, while the value of domestic exports was $17,276,000. In comparison with 1929, there were decreases in the value of packaged fish, canned fish, secondary products, and imports and exports, while the production of frozen fish increased.

INTERNATIONAL RELATIONS

REVISED NORTHERN PACIFIC HALIBUT CONVENTION

The investigations of the International Fisheries Commission provided for under the convention with Great Britain and Canada, ratified October 21, 1924, have shown that the stock of northern

Pacific halibut is in a precarious condition, faced with ultimate exhaustion, unless the fishery is properly controlled. It will be appreciated that it is a complicated and difficult problem to exercise adequate control over a living organism, and particularly so when that organism is a species of fish inhabiting the depths of the ocean over a coastwise stretch of more than 2,000 miles. Under this convention the commission was required to make recommendations to the two Governments for concurrent action as to the regulations deemed necessary for the preservation and development of the fishery. It is a most difficult if not impracticable procedure to obtain consideration of minor regulations by the Congress of the United States and the Canadian Parliament each year. To provide a simpler, more responsive system of control a revised convention with Canada was signed on May 9, 1930, and became effective on May 9, 1931, by the exchange of ratifications at Ottawa. It was proclaimed by the President on May 14, 1931, and contains the following articles:

ARTICLE I

The nationals and inhabitants and fishing vessels and boats of the United States of America and of the Dominion of Canada, respectively, are hereby prohibited from fishing for halibut (Hippoglossus) both in the territorial waters and in the high seas off the western coasts of the United States of America, including the southern as well as the western coasts of Alaska, and of the Dominion of Canada, from the first day of November next after the date of the exchange of ratifications of this Convention to the fifteenth day of the following February, both days inclusive, and within the same period yearly thereafter.

The International Fisheries Commission provided for by Article III is hereby empowered, subject to the approval of the President of the United States of America and of the Governor General of the Dominion of Canada, to suspend or modify the closed season provided for by this article, as to part or all of the convention waters, when it finds after investigation such changes are necessary.

It is understood that nothing contained in this convention shall prohibit the nationals or inhabitants or the fishing vessels or boats of the United States of America or of the Dominion of Canada, from fishing in the waters hereinbefore specified for other species of fish during the season when fishing for halibut in such waters is prohibited by this Convention or by any regulations adopted in pursuance of its provisions. Any halibut that may be taken incidentally when fishing for other fish during the season when fishing for halibut is prohibited under the provisions of this Convention or by any regulations adopted in pursuance of its provisions may be retained and used for food for the crew of the vessel by which they are taken. Any portion thereof not so used shall be landed and immediately turned over to the duly authorized officers of the Department of Commerce of the United States of America or of the Department of Marine and Fisheries of the Dominion of Canada. Any fish turned over to such officers in pursuance of the provisions of this article shall be sold by them to the highest bidder and the proceeds of such sale, exclusive of the necessary expenses in connection therewith, shall be paid by them into the treasuries of their respective countries.

It is further understood that nothing contained in this convention shall prohibit the International Fisheries Commission from conducting fishing operations for investigation purposes during the closed season.

ARTICLE II

Every national or inhabitant, vessel or boat of the United States of America or of the Dominion of Canada engaged in halibut fishing in violation of the preceding article may be seized except within the jurisdiction of the other party by the duly authorized officers of either High Contracting Party and detained by the officers making such seizure and delivered as soon as practicable to an authorized official of the country to which such person, vessel or boat belongs, at the nearest point to the place of seizure, or elsewhere, as may be agreed upon. The authorities of the nation to which such person, vessel or

boat belongs alone shall have jurisdiction to conduct prosecutions for the violation of the provisions of this Convention, or any regulations which may be adopted in pursuance of its provisions, and to impose penalties for such violations; and the witnesses and proofs necessary for such prosecutions, so far as such witnesses or proofs are under the control of the other High Contracting Party, shall be furnished with all reasonable promptitude to the authorities having jurisdiction to conduct the prosecutions.

ARTICLE III

The High Contracting Parties agree to continue under this Convention the Commission as at present constituted and known as the International Fisheries Commission, established by the Convention between the United States of America and His Britannic Majesty for the preservation of the halibut fishery of the Northern Pacific Ocean including Bering Sea, concluded March 2, 1923, consisting of four members, two appointed by each Party, which Commission shall make such investigations as are necessary into the life history of the halibut in the convention waters and shall publish a report of its activities from time to time. Each of the High Contracting Parties shall have power to fill, and shall fill from time to time, vacancies which may occur in its representation on the Commission. Each of the High Contracting Parties shall pay the salaries and expenses of its own members, and joint expenses incurred by the Commission shall be paid by the two High Contracting Parties in equal moieties.

The High Contracting Parties agree that for the purposes of protecting and conserving the halibut fishery of the Northern Pacific Ocean and Bering Sea, the International Fisheries Commission, with the approval of the President of the United States of America and of the Governor General of the Dominion of Canada, may, in respect of the nationals and inhabitants and fishing vessels and boats of the United States of America and of the Dominion of Canada, from time to time,

(*a*) divide the convention waters into areas;

(*b*) limit the catch of halibut to be taken from each area;

(*c*) fix the size and character of halibut fishing appliances to be used therein;

(*d*) make such regulations for the collection of statistics of the catch of halibut including the licensing and clearance of vessels, as will enable the International Fisheries Commission to determine the condition and trend of the halibut fishery by banks and areas, as a proper basis for protecting and conserving the fishery;

(*e*) close to all halibut fishing such portion or portions of an area or areas, as the International Fisheries Commission find to be populated by small, immature halibut.

ARTICLE IV

The High Contracting Parties agree to enact and enforce such legislation as may be necessary to make effective the provisions of this Convention and any regulation adopted thereunder, with appropriate penalties for violations thereof.

ARTICLE V

The present Convention shall remain in force for a period of five years and thereafter until two years from the date when either of the High Contracting Parties shall give notice to the other of its desire to terminate it.

This Convention shall, from the date of the exchange of ratifications be deemed to supplant the Convention between the United States of America and His Britannic Majesty for the Preservation of the Halibut Fishery of the Northern Pacific Ocean including Bering Sea, concluded March 2, 1923.

ARTICLE VI

This Convention shall be ratified in accordance with the constitutional methods of the High Contracting Parties. The ratifications shall be exchanged at Ottawa as soon as practicable, and the Convention shall come into force on the day of the exchange of ratifications.

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PASSAMAQUODDY POWER PROJECT

By joint resolution (Pub. Res. No. 83, 71st Cong.) approved June 9, 1930, Congress authorized an appropriation to defray the United States' share of the expenses of an investigation, to be made jointly by the United States and Canada, of the probable effects on the fisheries of the proposed international developments to generate electric power from the movements of the tides in the Passamaquoddy and Cobscook Bays region. The President appointed Henry O'Malley, Commissioner of Fisheries, and O. E. Sette, in charge of North Atlantic fishery investigations of this bureau, as the United States commissioners to conduct the investigations. Wm. A. Found, Deputy Minister of Fisheries, and Prof. A. G. Huntsman, of the Biological Board of Canada, were appointed to represent Canada.

The commission met on June 8, 1931, in Montreal to organize and to consider arrangements for initiating the investigation. Mr. Found was chosen chairman and plans were made for the selection of four responsible investigators to conduct investigations on zooplankton, phytoplankton, oceanic chemistry, physical oceanography, and fisheries. The investigations are planned along the following lines:

1. Detailed study of the occurrence of the herring in relation to various environmental conditions as an indication of how its availability in the fishery might be affected by the construction of the dams.

2. A study of the abundance of phytoplankton and zooplankton (as a basis for fish life) in relation to the physical and chemical states of the water in the Bay of Fundy and along the coast of Maine.

3. Detailed examination of existing hydrographic conditions as indicating the relative importance of the water mixing at the mouth of Passamaquoddy Bay as determining the physical and chemical states of the water in the Bay of Fundy and along the coast of Maine. The commission and investigative staff will be aided by an advisory committee of four scientists. For Canada these are: Prof. F. R. Hayes, zoological department, Dalhousie University, and Dr. A. W. H. Needler, in charge of oyster investigations; and for the United States, Dr. H. B. Bigelow, director of the Woods Hole (Mass.) Oceanographic Institution, and Prof. A. E. Parr, curator, Bingham oceanographic collection, Yale University.

NORTH AMERICAN COUNCIL ON FISHERY INVESTIGATIONS

The council held its seventeenth meeting in Washington, D. C., on November 6 and 7, 1930, with representatives from Canada, France, Newfoundland, and the United States present. The meeting concerned itself with a wide range of subjects dealing with the practical and scientific problems of our North Atlantic fisheries in keeping with its purpose to coordinate the program of research along eminently practical lines. Reports on investigations of the cod, haddock, mackerel, herring, and squid fisheries, the Passamaquoddy power project, ocean currents and temperatures, and fishery statistics were received. Dr. Ed. le Danois, director of the marine-fisheries work in France, gave a very interesting account of the movement of North Atlantic waters and their effects on the fisheries, and the Hon. H. B.

C. Lake, Minister of Marine and Fisheries of Newfoundland, emphasized the seriousness of the bait situation and need for assuring to the fishermen adequate supplies of bait material. Dr. Harold Thompson, a well-known investigator of the Scottish Fishery Board, who is cooperating with the Newfoundland Government in working out a program of fishery research, was present.

INTERNATIONAL COLONIAL EXPOSITION AT PARIS

In connection with the participation by the Government of the United States in the International Colonial and Overseas Exposition at Paris from May 1 through October, 1931, the bureau prepared an appropriate display regarding the fishery and fur-seal industries of Alaska. The articles assembled included a life-size reproduction of a chinook salmon, models of salmon steaks and fillets, salmon and clam cans and labels, a mounted fur seal, several dressed and dyed fur-seal skins, and two fur-seal coats. Appropriate photographic presentations were also included.

CONSERVATION OF WHALES

At one period the United States led all nations in the prosecution of the whale fisheries. It still produces from one to one and a half million gallons of whale oil and imports over seven million gallons, making it a large consumer of this product.

During the past quarter of a century the prosecution of this fishery on all seas has been greatly intensified. The development of floating factory ships with a displacement up to 30,000 tons or more, some of the larger with storage space for three and one-half to six million gallons of oil, has made possible an intensive exploitation of the fishery in Antarctic waters. The mother ship is accompanied by a fleet of "killers," smaller swift vessels, to scour the seas and tow the catch to the factory ship. On some of these factory ships there is provision for hauling the whales aboard for cutting up, thus greatly simplifying reduction operations.

The world catch of whales increased from about 12,000 in the calendar year 1920 to more than 27,500 in 1929, and the production of whale oil increased from nearly 20,400,000 gallons to 93,400,000 gallons in this 10-year period.

This intensified pursuit of whales in practically all seas of the globe has aroused grave concern lest the supply be exhausted and the investment in the industry, which has yielded over $60,000,000 in products in a year, be jeopardized. Because of the cosmopolitan character of whales and the number of countries engaged in the fishery, regulation would appear necessary by international agreement. In Europe some provision for the study of the subject has been made, and several nations have applied some restrictions on the operation of their nationals. In this country the question is receiving attention by the Special Committee on Wild Life Resources of the United States Senate, the American Society of Mammalogists, and other conservation agencies.

Among the protective measures which should receive attention are the prevention of the capture of certain of the rarer species, the killing of immature whales of whatever species, and the undue exploita-

tion of the fishery as a whole. It may be necessary to provide for the licensing of whaling companies, setting forth the terms under which they shall operate, including as complete utilization of the animals killed as is practicable. It is also highly important that an international agency be established for a more intensified study of the trend of the fishery, the need for regulations, and the character of regulations essential to prevent the exhaustion of the supply, with as little interference with commercial operations as possible.

JAPANESE VESSELS IN BERING SEA

The summer of 1930 marked the advent of Japanese vessels in Bering Sea waters adjacent to the Alaskan coast for the packing of crabs. The floating cannery steamer *Taihoku Maru*, a vessel of over 7,000 tons, accompanied by the steam beam trawler *Myogi Maru* and a number of power launches, was operated about 20 miles offshore from Nelson Lagoon on the Alaska Peninsula. A pack of upward of 20,000 cases of crabs was made. The trawler *Kokusai Maru*, a vessel 118 feet in length, engaged in experimental fishing in Bristol Bay waters 15 or more miles offshore in August, 1930, a small take of cod, crabs, and halibut resulting. In addition, the Japanese Government vessel *Hakuyo Maru* made a trip in 1930 to waters of Bering Sea. This is a training ship of the Imperial Fisheries Institute of Tokyo and is a modern steel vessel of about 2,000 tons. In the summer of 1931 the floating cannery *Nagato Maru* was engaged in the packing of crabs in Bering Sea waters a few miles north of the Alaska Peninsula.

DOMESTIC RELATIONS

AID TO OUR ISLAND DEPENDENCIES

Hawaiian pearl oysters.—At the invitation of the Territorial government of Hawaii, the bureau detailed its oyster expert, Dr. P. S. Galtsoff, to an investigation of the newly discovered pearl-oyster resources of Pearl and Hermes Reef for the purpose of developing a conservation policy. Transported from Honolulu on July 15, 1930, by the Navy mine layer *Whippoorwill* and accompanied by 3 Philippine divers, Doctor Galtsoff spent 5 weeks in making a series of biological investigations at 75 stations in the lagoon where the oysters occur. Pearl oysters were found at depths from 10 to 47 feet, attached almost exclusively to live corals. All oyster reefs examined showed obvious signs of depletion. One-year-old oysters were very few in number. The oysters spawn in July and August. It is estimated that since 1927, when these beds were discovered, not less than 100 tons of shells (about 106,000 oysters) were taken; and, without protection, the beds will be completely wiped out in a short time. The closure of the beds to fishing for a period of 3 to 5 years was recommended. Several hundred live oysters were brought back to Honolulu and planted in Kaneohe Bay, where conditions appeared to be suitable for their growth and propagation. An examination of this stock made on April 17, 1931, disclosed that the oysters were doing well, those examined having nearly doubled in size since they were planted in the previous September. The Territorial government

is making arrangements to bring more oysters from Pearl and Hermes Reef in the continuance of the restocking policy.

Fisheries of the Virgin Islands.—R. H. Fiedler and N. D. Jarvis, on May 2, 1931, were detailed to conduct a survey of the fisheries of the Virgin Islands of the United States with a view to alleviating the present economic plight of these islands. Work began on May 15, 1931, in St. Thomas, and the preliminary survey was completed on May 30, 1931. The survey revealed that during the calendar year 1930 the fisheries of the Virgin Islands of the United States employed 405 fishermen. Their catch amounted to 616,000 pounds of fishery products valued at $49,080 to the fishermen. In making the catch the fishermen used 1 motor boat, 38 sailboats, and 147 rowboats. The gear employed consisted of 40 haul seines, 90 tangle nets (turtle), 113 cast nets, 297 lines, and 1,600 set pots. About one-third of the total catch was made by set pots, one-third by seines, and one-third by lines or other types of gear, and by hand. In addition, it was determined that the industry in the islands is faced with the problem of marketing the catch now obtained rather than the lack of a sufficient supply. There is reason to believe that there are many times throughout the year when the local markets are glutted with fish, making it impossible to dispose of the catch. Two plans appeared feasible for relieving the situation. These are: (1) Expand the market for fresh fish; (2) establish a local fish-curing industry to replace imported cured fish. In order to further these plans Mr. Jarvis remained in the islands for several weeks to conduct experiments along these lines. These experiments have proved successful; and if the findings are adopted it is believed that the economic welfare of the fisheries of the islands will be materially improved.

FISHERIES CONFERENCES

On October 27 and 28, 1930, the bureau was represented at an important interstate fishery conference at Savannah, Ga., called by the fish and game commissioner of Georgia to consider various fishery problems of common interest to North Carolina, South Carolina, Georgia, and Florida, with special reference to oysters, shad, and shrimp. The conference adopted a resolution favoring extension of private oyster culture and the application of modern methods of oyster farming, also one favoring restriction of the shad fisheries, protection of spawning grounds, and provision for escapement of a sufficient spawning reserve.

At the invitation of the Commissioner of Fisheries, conservation officials and leading conservationists of Maryland, Virginia, West Virginia, Pennsylvania, and the District of Columbia met at the bureau on December 9, 1930, to formulate a program for the rehabilitation of the game fishes, particularly the black bass, the control of pollution, and the protection of the shad in the Potomac River.

Resolutions were passed recommending (1) uniform laws governing the fisheries in boundary waters; (2) measures designed to afford the black bass proper protection; (3) effective laws for the protection of the shad; (4) the enactment of legislation by the States for more complete sewage and trade waste disposal; (5) provisions for cooperative study on means for disposing of industrial wastes; and (6) the prevention of the pollution of streams.

In providing effective cooperation with the Federal Government in the enforcement of the black bass law it was recommended that the States (1) prohibit the sale of black bass whether taken within or without the State; (2) provide entire closure to fishing during the spawning season of the bass; (3) prohibit the export of bass, allowing the nonresident licensee to carry out a 2-day bag limit; (4) provide a uniform size limit; and (5) provide a daily bag limit; and further that the Federal and State agencies increase their output of young bass to care for the demand from private cooperative agencies desirous of rearing the young to fingerling sizes for stocking purposes and for more generous plantings in the streams.

COOPERATION WITH STATES

With the work of the bureau extending into every State, cooperative arrangements are frequently entered into with the various agencies engaged in similar work. This prevents duplication of effort and effects a considerable saving of money for all concerned.

In its limnological survey of Lake Erie the bureau has been aided by the States of Ohio and New York. Similar arrangements exist with Wisconsin in the lake work of that State. Cooperative arrangements with Georgia, Louisiana, and Texas in the shrimp work have greatly enlarged its scope, the two former States financing the operations of two of the bureau's vessels assigned to their waters. California is assisting with the trout and steelhead salmon studies on the Pacific slope. The oyster work of the bureau has been materially aided by the cooperation of Virginia, North and South Carolina, Georgia, Oregon, and Washington. In the fish cultural work the Rocky Mountain States have been very helpful in the program of restoring the depleted streams of this popular fishing section to former abundance by mutually beneficial cooperative egg collecting and rearing operations. In addition, cooperation has been received in this work from many of the other States, notably Michigan, Minnesota, Washington, and Oregon. In so far as personnel is available expert advice has been freely granted to State and private fish-culturists in the solving of their various problems. Exceptional cooperation also has been received in the collection of statistics. Many States furnish data so complete that only supplemental surveys need be made by the bureau's agents. In the enforcement work of the new black bass law the bureau, on account of limited funds, has had to depend on State help and cooperation to expedite the program. This has been freely given, and many of the States are assisting by allowing the appointment of their regularly employed State fish and game protectors to the cooperative position of Federal black bass law inspectors, for which they receive no remuneration, thus rendering a distinct service in a very material way.

In addition to the States, the Navy Department, through the transporting of supplies to the Pribilof Islands, has given valuable and much appreciated aid and, together with the War Department, has loaned vessels for other services as well. The United States Forest Service and the National Park Service rely upon the bureau for fish for stocking the streams and lakes in their reservations and cooperate to the fullest extent.

FIVE-YEAR CONSTRUCTION AND MAINTENANCE PROGRAM

The act of May 21, 1930 (46 Stat. 371), entitled "An act to provide for a 5-year construction and maintenance program for the United States Bureau of Fisheries," authorized, among other things, the establishment, during the fiscal year 1931, of fish cultural stations in New Mexico, Louisiana, and Idaho; fish cultural substations in Wisconsin, Montana, Colorado, and New Hampshire; a fishery laboratory in the State of Washington; and an experimental bass and trout station in Maryland or West Virginia. A total of $505,000 was authorized to be appropriated for the establishment of these projects. The second deficiency act, fiscal year 1930, appropriated $265,000 for the fiscal year 1931 to enable the bureau to establish or to commence the establishment of these projects.

Sites suitable for the establishment of the fish-cultural substation in New Hampshire and for the fishery laboratory in the State of Washington were available on land already owned by the United States and consequently their establishment was begun early in the fiscal year and practically completed. The New Hampshire station is located in the White Mountain National Forest near the town of West Milan. The laboratory is located at 2725 Montlake Boulevard, Seattle, Wash., on land known as the "Old Lake Washington Canal right of way."

Sites near Natchitoches, La., Leadville, Colo., and Charles Town, W. Va., were acquired for the establishment of the stations in those States and construction was begun during the year.

Sites near Dexter, N. Mex., Gooding, Idaho, and Lake Mills, Wis., were selected for the stations to be established in those States; but title to these sites was not perfected during the fiscal year, and necessarily construction could not be begun.

PROPAGATION AND DISTRIBUTION OF FOOD AND GAME FISHES

INTRODUCTION

The operations of the fish-cultural division of the Bureau of Fisheries include the propagation and distribution of marine and fresh-water fishes. As a result of such activities during the fiscal year 1931, 7,121,806,000 fish and eggs were produced and distributed. This represents a decrease in output of 448,677,000 as compared with the preceding year.

Two important facts to be taken into consideration in comparing the output of one fiscal year with that of another are the amount of equipment employed and the size of the fish produced. The equipment in operation during 1931 was essentially the same as in 1930. Carp propagation was suspended at the Put in Bay (Ohio) station. Ponds for warm-water fishes were constructed in rice fields in the vicinity of Orangeburg, S. C. At Pyramid Lake, Nev., extensive collections of black-spotted trout eggs were made. Black bass ponds covering an area of approximately 4 acres were completed at the Cape Vincent (N. Y.) station and placed in operation. These changes were not of great magnitude, and the equipment employed

during the two years may be considered on an approximately equal basis.

The experience gained in the planting of large fingerling and yearling trout, salmon, and other fishes that can be reared to fingerling and yearling sizes has demonstrated that the distribution of such fishes in the egg and fry stages should not be resorted to except when lack of adequate facilities makes it imperative. The significance of the planting of 1,000 large fingerling fish might easily overshadow the planting of many times that number of fish of the same species in the fry stage. Because of this fact much of the expansion of fish-cultural equipment and effort for the production of certain fishes has taken place with the view to producing fish of larger size rather than increasing the numerical output.

The continued efforts put forth by the bureau to produce larger fish have resulted in the distribution of a greater proportion of the output in the fingerling stage. Such increase in the fiscal year 1931 as compared with the fingerling production of the preceding year amounted to 28 per cent. Since these larger fish require more space and care than fish in the fry stage, it might be assumed that the total production of the hatcheries in operation would be proportionately reduced. As a matter of fact, however, only two species of salmon—steelhead and chum—showed any appreciable decrease in numbers as compared with 1930, while the chinook, sockeye, humpback, and Atlantic salmons showed a substantial increase in production. The output of the other salmons and trout handled did not vary markedly from the figures of the preceding year.

There was an increased output of practically all the important commercial and game species handled, and in the case of the shad, herring, cisco, pike perch, and winter flounder such increases were large. The decline in the total output may be ascribed largely to a falling off in the production of cod and pollock, such decrease amounting to 1,135,999,000. These species are distributed in the egg and fry stages, and the egg collections are dependent upon the weather conditions encountered rather than upon the efficiency and effort put forth by the egg-collecting crews. Aside from the cod and pollock operations, the fiscal year 1931 may be regarded as a most successful year from a propagation and distribution standpoint. The year's output, classified according to the character of the fishes handled, may be summarized as follows:

	Number
Game fishes:	
Warm-water species—	
Basses	4,370,000
Sunfish	12,653,000
Crappie	28,549,000
Pike and pickerel	3,927,000
Catfish	84,521,000
Other	101,000
Cold-water species:	
Trouts—	
Brook	16,296,000
Rainbow	13,389,000
Loch Leven	16,702,000
Black-spotted	16,095,000
Golden	25,000
Grayling	1,003,000
Landlocked salmon	708,000

	Number
Commercial fishes:	
Anadromous species—	
Shad	19,490,000
Glut herring	50,000,000
Striped bass	9,500,000
Salmon—	
Atlantic	3,969,000
Pacific	175,748,000
Interior waters (including Great Lakes) species—	
Whitefish	157,415,000
Cisco	63,400,000
Lake trout	25,729,000
Pike perch	195,353,000
Yellow perch	115,298,000
Carp	138,023,000
Buffalofish	115,488,000
Marine species—	
Cod	1,525,298,000
Haddock	447,428,000
Pollock	240,219,000
Winter flounder	3,604,668,000
Mackerel	10,461,000
Miscellaneous fishes	25,980,000
Total	7,121,806,000

PROPAGATION OF COMMERCIAL SPECIES

Marine species of the Atlantic coast.—As the fishes propagated by the bureau in this section are extremely prolific, the eggs are taken in immense numbers. Most of them are incubated in hatcheries and the fry liberated soon after hatching. However, the low-water density experienced in some of the egg-collecting fields makes it imperative to plant the green eggs on the spawning grounds immediately after fertilization has been accomplished. A considerable increase may be noted in the distribution of haddock and winter flounder. On the other hand, the production of cod and pollock fell far short of the results with these species in the preceding year.

Pacific salmon.—The output of Pacific salmon was considerably in excess of last year's production. Owing to the more favorable conditions existing on the spawning grounds in the Columbia River and in California, the egg collections of the chinook salmon exceeded those of last year by more than 40,000,000. More eggs of the humpback salmon than last year were taken in the Afognak (Alaska) field.

Anadromous species of the Atlantic coast.—A comparatively successful year was experienced in the propagation of shad. A prolonged period of cool weather lengthened the spawning season, and while the egg collections did not equal those in the spring of 1929, they exceeded the take in 1930 by a substantial margin. Eggs of the striped bass were again collected at Weldon, N. C., after a year of no production in 1930. Atlantic salmon propagation was augmented at the Craig Brook (Me.) station by the acquisition of several million additional eggs from Canadian hatcheries, and at Edenton, N. C. the 1930 take of herring eggs was surpassed by upward of 70,000,000.

Commercial species of interior waters.—Increases over 1930 figures may be noted in the 1931 distributions of the fishes coming under

this head. Pike perch and cisco showed large increases, the Put In Bay (Ohio) station producing a very satisfactory output of the former. The whitefish production exceeded that of 1930, due mainly to more satisfactory working conditions in the Michigan field. Notwithstanding the fact that carp propagation was suspended at the Put In Bay station, a large increase in the carp output was made possible through operations conducted at Bellevue and Guttenberg, Iowa, in the La Crosse (Wis.) field.

PROPAGATION OF GAME FISHES

Although a number of the commercially important fishes are sought by anglers for their sporting qualities, many of them are not included in the category of game fishes. Only the trouts, basses, sunfish, crappie, catfish, pike, pickerel, grayling, and related forms are comprised under that heading.

During the year difficulties were experienced at some of the pondfish stations on account of the prevailing drought. Large losses of black bass and other pondfishes were also sustained because of the varying weather conditions experienced during the spawning season. Notwithstanding these handicaps, however, the year's distribution of the pondfishes was only slightly lower than in 1930. In all sections a sufficient number of the various species was produced to fill all applications on file and to allow for the utilization of an ample surplus for carrying on extensive cooperative activities with States, sportsmen's organizations, and individuals.

RESCUE OPERATIONS

The extent of the rescue work in the Mississippi River territory exceeded that of the previous year. The total of salvaged fish handled in the fiscal year 1931 amounted to 182,534,861, and of this number less than 1 per cent was used to fill applications outside of the rescue district. Weather conditions were unusually favorable during the season, and the number of fish rescued constituted a new record. The results of the rescue work in the fields surrounding the Fairport (Iowa) biological station were also very successful.

COOPERATIVE ACTIVITIES

The cooperative nursery system has become an integral part of the bureau's propagation work. Through its activities the bureau has been enabled to extend materially the scope of its fish-cultural operations. The removal of large numbers of young fish to be reared at the nurseries has reduced the mortality formerly resulting from the crowded condition of the hatcheries and has made possible the concentration of effort in rearing the retained stock to a comparatively large size prior to distribution. While the drought and other conditions caused the suspension of activities at a number of these establishments, the 119 in operation received for rearing during the year a total of 4,109,622 young fish produced at the bureau's hatcheries.

STATISTICAL SURVEYS

The statistical work of the division of fishery industries includes the collection and dissemination of biological and trade-fishery statistics. Continued progress was made toward the collection of annual statistics of the entire country by the cooperation of State fishery agencies and by the use of automobiles by agents. As a result, catch statistics for 1929 were obtained for the fisheries of the entire United States with the exception of certain fisheries of the Mississippi River and tributaries.

FISHERIES OF THE UNITED STATES AND ALASKA

New England States.—In the calendar year 1929 the fisheries of Maine, New Hampshire, Massachusetts, Connecticut, and Rhode Island employed 17,160 fishermen, or 3 per cent more than in 1928. The catch amounted to 694,286,086 pounds, valued at $29,072,566—an increase of 15 per cent in the catch and 13 per cent in value as compared with 1928.

In 1930 landings of fish by American vessels at Boston and Gloucester, Mass., and Portland, Me., amounted to 350,801,470 pounds as landed, valued at $12,785,452—an increase of 7 per cent in volume over 1929.

The catch of the mackerel fishery in 1930 amounted to 43,156,885 pounds, which is a decrease of 7 per cent as compared with 1929.

In 1930 the packaged-fish trade in New England decreased 7 per cent in amount and 18 per cent in value as compared with 1929.

The sardine canners in Maine packed 1,399,212 standard cases, valued at $4,459,071, during 1930—a decrease of 31 per cent in quantity and 35 per cent in value as compared with 1929.

Middle Atlantic States.—In the calendar year 1929 the fisheries of New York, New Jersey, Pennsylvania, and Delaware employed 10,491 fishermen, or 5 per cent more than in 1926, the most recent year for which statistics are available prior to 1929. The catch amounted to 190,772,611 pounds, valued at $14,137,608—an increase of 14 per cent in the catch and 13 per cent in the value of the catch as compared with 1926. Landings of fish at New York City and Groton, Conn., amounted to 57,255,000 pounds in 1930, or 24 per cent less than in 1929.

On the Hudson River the shad fishery was carried on by 243 fishermen in 1930, who caught 206,504 pounds of shad, valued at $33,372—a slight increase over 1929.

Chesapeake Bay States.—In the calendar year 1929 the fisheries of Maryland and Virginia employed 18,470 fishermen, or 26 per cent less than in 1925, the most recent year for which records are available prior to 1929. The catch amounted to 274,673,437 pounds, valued at $11,580,628—a decrease of 18 per cent in the catch and 17 per cent in the value of the catch as compared with 1925.

In 1930 the shad and alewife fisheries of the Potomac River were prosecuted by 608 fishermen, who caught 601,193 pounds of shad, valued at $98,041, and 3,114,918 pounds of alewives, valued at $49,315.

South Atlantic and Gulf States.—In the calendar year 1929 the fisheries of North Carolina, South Carolina, Georgia, Florida, Ala-

bama, Mississippi, Louisiana, and Texas employed 26,643 fishermen, or 7 per cent less than in 1928. The catch amounted to 535,394,859 pounds, valued at $14,903,945—an increase of 18 per cent in the catch and a decrease of 7 per cent in the value as compared with 1928.

In 1930 sponges sold on the exchange at Tarpon Springs, Fla., amounted to 414,082 pounds, valued at $802,938. This is an increase of 9 per cent in quantity and 14 per cent in value over 1929.

Pacific Coast States.—In the calendar year 1929 the fisheries of Washington, Oregon, and California employed 19,992 fishermen, or 1 per cent more than in 1928. The catch was the largest and most valuable on record, amounting to 1,034,433,666 pounds, valued at $25,038,414—an increase of 47 per cent in the catch and 22 per cent in the value over 1928.

In 1930 the total catch of halibut by United States and Canadian vessels amounted to 49,408,000 pounds, valued at $4,974,000—a decrease of 11 per cent in quantity and 26 per cent in value as compared with 1929.

Lake States.—In the calendar year 1929 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 114,826,907 pounds of fish and shellfish. Of the total, the United States accounted for 85,389,467 pounds, valued at $6,787,750. The total catch showed an increase in 1929 over 1928, due largely, however, to a revised and more complete method of collection used in the lake fisheries in 1929.

Mississippi River and tributaries.—During the calendar year 1930 the catch of fresh-water mussel shells amounted to 59,490,000 pounds, valued at $1,092,156—an increase of 9 per cent in the quantity and a decrease of 18 per cent in the value as compared with 1929. The pearl-button industry, centered in Iowa, manufactured pearl buttons and various novelties from fresh-water mussel shells valued at $5,007,419 in 1930. The fisheries of Lakes Pepin and Keokuk decreased in 1930 as compared with 1929.

MANUFACTURED PRODUCTS

Canned products.—During the calendar year 1930, 464 establishments canned fishery products in the United States and Alaska amounting to 14,767,186 standard cases (576,685,454 pounds), valued at $82,858,261. This is a decrease of 18 per cent in the value as compared with 1929. Salmon canned on the Pacific coast accounted for 6,086,479 standard cases (292,150,992 pounds), valued at $42,835,953. This is 52 per cent of the total value. Sardines canned in California and Maine and tuna and tunalike fishes canned in California each accounted for 16 per cent of the total value. The remainder of the production consisted principally of shrimp, clam products, and oysters.

By-products.—During the calendar year 1930 by-products worth $23,720,778 were manufactured. Excluding marine-pearl shell products, statistics for which were not included in 1929, there was a decrease of 19 per cent in the value of the production. The most important by-products were marine-animal meals and scrap, fresh-

water mussel-shell products, marine-pearl shell products, marine-animal oils, and oyster-shell products. Products of lesser importance were liquid glue, herring skins and scales, shark skins, fins, and meat, agar agar, pickled whale meat, whalebone, and isinglass.

Cured products.—The production of cured fishery products in the marine and lake sections of the United States and Alaska in the calendar year 1929 amounted to 116,267,121 pounds, valued at $17,822,253. Of this amount 72,842,774 pounds, valued at $7,038,425, were salted; 36,490,815 pounds, valued at $9,446,612, were smoked; 4,746,634 pounds, valued at $1,214,205, were dried; and 2,186,898 pounds, valued at $183,011, were spiced. Mild-cured salmon was the most valuable salted product, salmon the most valuable smoked product, shrimp the most valuable dried product, and alewives the most important spiced product.

Packaged fresh, frozen, and smoked products.—During the calendar year 1930 packaged fresh, frozen, and smoked products were produced in 128 plants operated in 15 States. The output amounted to 80,013,572 pounds, valued at $12,579,664—a decrease of 5 per cent in quantity and 15 per cent in value as compared with 1929.

Frozen products.—In the calendar year 1930 the freezing plants in the United States and Alaska packed 139,297,228 pounds of frozen fishery products, with an estimated value in the cold-storage warehouses of $16,500,000. This is the largest frozen pack on record and is an increase of 15 per cent over 1929. The most important frozen products were the group consisting of cod, haddock, haddock fillets, hake, and pollock; salmon; halibut; mackerel; whiting; and sea herring.

FISH-FARMING INDUSTRIES IN THE UNITED STATES

As a continuation of the work started in the calendar year 1928 when the goldfish industry was surveyed, the fish-farming industry was further studied in 1930 to include the trout and pondfish industries. It was found that there were 133 trout and 11 pondfish establishments commercially active in 1929. The products marketed in the trout industry were valued at $1,072,700, and in the pondfish industry they were valued at $21,444.

FOREIGN FISHERY TRADE

The value of the United States foreign trade in fishery products during the calendar year 1930 amounted to $68,105,230, of which $50,829,653 represents the value of the imports for consumption and $17,275,577 the value of exports. Compared with the previous year, this is a decrease of 25 per cent in total trade, 24 per cent in the value of imports, and 28 per cent in the value of exports.

TECHNOLOGICAL INVESTIGATIONS

The technologists of the division of fishery industries have been conducting research mainly on problems relating to improvements in methods of handling fresh fish, by-products and production methods, net preservation, and the nutritive value of marine products.

IMPROVEMENTS IN METHODS OF HANDLING FRESH FISH

During the year the bureau established a refrigeration laboratory at the municipal fish market in this city for the purpose of continuing preliminary studies on the evaporation of moisture from frozen fish, the rusting of frozen fish, the losses incurred through leaching of fish packed in ice, and the freezing of oysters. In the studies on the evaporation of moisture from frozen fish, the samples of fish were given several different treatments and stored in a constant temperature approximating the conditions of a commercial freezer as far as possible. One treatment showed up particularly well, reducing the evaporation of moisture from 23 per cent in the untreated fish to 5 per cent in the treated fish. In studying the losses incurred through the leaching of fish packed in ice, preliminary experiments indicated losses of as high as 4 pounds per ton over a period of 7 days. This, apparently, is not a great loss until it is multiplied by the amount of fish handled in crushed ice over a period of a year. It then begins to assume proportions which are really surprising. It has been recognized for several years and should be emphasized that these losses represent some of the most important constituents of the fish from a nutrition standpoint, as the leachings contain large quantities of the minerals and a part of the flavor of the fish.

During the past year experiments have been conducted on freezing oysters. If rapidly frozen oysters could be introduced for consumption in the summer months and the public induced to buy them, the annual output of the producers could be materially increased. Our experiments have demonstrated that oysters can be rapidly frozen and placed in cold storage for several months without impairing the taste.

At the time that the above-described experiments were being conducted, at the request of the authorities of the District government, our technologist offered suggestions which would tend to increase the attractiveness of the municipal fish market. These dealt with the sanitary conditions, improvements in refrigeration facilities for the stores, and general recommendations.

BY-PRODUCTS AND PRODUCTION METHODS

Activities in this section of technology consisted in the completion of studies on the menhaden industry, manufacturing fish oils of higher vitamin potency, cooking and pressing fish, and reduction of nonoily fish waste.

The menhaden studies disclosed means for the elimination of wastage in the various stages of the factory process, the more efficient operation of machinery, possible improvements in the design of existing machinery, and the introduction of new machinery.

It has been shown that menhaden press liquors contain approximately 22 per cent of the total solids of the original material, and of this amount about 17 per cent is dissolved material and about 5 per cent is suspended material. Under present operating conditions, all dissolved materials are discarded and only about one-third of the suspended materials are recovered. Yet, by treating press liquors with a chemical coagulant, such as aluminum sulphate,

and passing the liquors through a pressure filter, the oil and water emulsion is broken and all suspended and about one-third of the dissolved solids may be recovered. Furthermore, such treatment may be expected to give a greater oil recovery.

It was demonstrated that the type of flame drier used at present in the industry causes a loss of over 10 per cent of the monetary value of the scrap dried, and that the use of steam tube driers will reduce the present loss in monetary value of dried scrap by over 50 per cent. In addition to this advantage, preliminary feeding tests indicated that steam-dried menhaden meal has greater nutritional value than the flame-dried product. Another important discovery was the fact that storing of oil in open tanks at the factory causes an increase in the free fatty acid content of the oil.

Special studies have been made of the effect of different methods of manufacture on the quality and nutritive value of the finished products. It has been shown that the intrinsic value of both fish meal and fish oil can be greatly improved through changes in manufacturing methods. Heat and oxidation, both in intensity and duration, are the great destroyers of the nutritional value of foods and feedstuffs. Therefore, any food manufacturing process which minimizes the destructive effect of heat and oxidation contributes greatly to the quality and nutritive value of the manufactured product in question.

NET PRESERVATION

Net preservation studies dealt with trap nets and gill nets. Chemicals of the antioxidant class and bactericides were found to be valuable materials, in general, for treating nets. The proper handling of nets and preservative treatments, including the application of preservatives to nets, was studied in order to cut down labor cost and to minimize fire risk.

So many factors enter into the problem of prolonging the life of nets that these investigations have been pursued along four general lines of study as follows: (1) Development of chemical preservatives, (2) method of application of chemicals to textiles, (3) differences in deterioration by localities, and (4) yearly variability of deterioration in one locality.

NUTRITIVE VALUE OF MARINE PRODUCTS

Marine products represent an important food supply. These products are, generally speaking, rich in vitamins, and minerals in quantity and variety.

Cooperative research with the Bureau of Chemistry and Soils, U. S. Department of Agriculture, on fish oils, fish meals, fish flour, and oysters has been continued. Chemical and spectrographic analyses of the mineral elements in fish and shellfish meals and kelp meals have been conducted at Johns Hopkins University. A plan of cooperative research in the laboratories of the South Carolina Food Research Commission at Charleston, S. C., has been initiated in which a study is being made of the mineral content of oysters with relation to the prevention and cure of nutritional anemia. Various other cooperative tests with Federal and State agri-

cultural experiment stations have been provided to extend the nutritional studies of marine products to farm animals.

The number of nutritional studies relating to and depending on other phases of the bureau's technological investigations, together with demands for nutrition investigations from the industry, have compelled the bureau to establish its own nutrition laboratory. This has been done, and the investigations already under way are taxing the facilities of this laboratory.

The outstanding contribution, resulting from research in this field of technology, has been the demonstration of the richness of domestic fish oils in vitamins A and D. The quantities of the above-described American fish oils available at present are sufficient to take care of any present or increasing future needs. The increased utilization of these domestic fish oils for medicinal use and for animal feeding will add to the economic wealth of this country, benefiting both our agricultural and fishery industries, and will lessen our dependence on foreign sources of supply.

Recently considerable interest has been shown in fish flour—a product at the present time being prepared experimentally from the edible parts, including the backbone, of fish remaining from the filleting or packaged fish industry. This product is dried at a low temperature, under vacuum, and ground into a fine meal or flour. It has a pleasant taste, odor, and an attractive appearance. It can be made cheaply, as it comes from raw material which is now either a waste or is converted into fish meal for animal feeding. It may contain as high as 28 to 30 per cent of minerals, consisting largely of calcium and phosphorus. Laboratory investigations and baking tests, conducted by the cereal laboratory of the Bureau of Chemistry and Soils in cooperation with this bureau, have demonstrated that it is possible to incorporate 10 to 25 per cent of this fish flour in bakery products of a palatable and nutritious nature designed especially to appeal to children. Fish flour should be of considerable value in bone growth. Arrangements have been made with a public institution to make a special study of fish flour in the diet of children. Cooperation of the District of Columbia medical and dental societies has been extended to the bureau in connection with these tests.

GLOUCESTER LABORATORY

The bureau has established a large field laboratory at Gloucester, Mass., for the general conduct of technological research, including the following activities: Refrigeration, smoking, canning, bacteriology, by-products, and production methods. This laboratory has been equipped for both chemical and technological research and special equipment will be added from time to time as its research activities are expanded.

The first experimental projects to be started are: (1) Studies of improvements in methods of manufacture of fish flour and fish meal; (2) an investigation of the vitamin potency and chemical characteristics of haddock liver oil; (3) chemical studies of the refrigeration of fish; (4) methods for smoking fish; and (5) bacteriological studies aimed to improve fish products.

BIOLOGICAL FISHERY INVESTIGATIONS

The research activities of the scientific staff are addressed to the conservation of the Nation's aquatic food resources through encouraging and advising the States in their regulation of commercial and sport fishing, in perfecting methods of water farming and fish culture, and in providing the industries with sound and, in some cases, advance information as to the trend of the supply of commercial fishes. Major projects of research are conducted in each of the geographical interior and coastal sections of the United States.

Early in the fiscal year the division undertook an investigation of the haddock fishery—the most important fishery of the New England area. The fishery is subject to considerable fluctuations in yield; and recent evidences of decline in abundance, coupled with a tremendous expansion of the industry as a result of the packaged-fish business, have given rise to fears of serious depletion in the fishery. A comprehensive plan of investigation in the interest of conservation and the proper development of the resource, involving studies of changes in abundance of the stock and the possibilities of serious depletion, has been adopted, but such studies require considerable time for the production of results of practical value. Nevertheless, one phase of the investigation already has yielded results which promise to have signal value to the industry. A new type of savings trawl has been developed to permit the escape of virtually all fish below commercial size limits without reducing the catch of marketable fish. If this is adopted by the fishing industry, it should not only accomplish material economies in operation of the fishing vessels, but should be a positive factor in the conservation of the stock of fish in the sea.

Near the end of the fiscal year an agreement was reached with the California Division of Fish and Game for the conduct of a cooperative investigation of the trout and steelhead salmon situation in that State, and it is anticipated that the investigation will eventually include other Pacific coast areas. The streams of the western mountains have become so popular with anglers and vacationists that they are no longer able to withstand the strain of intensive fishing. New and improved methods of fish culture, of stocking, and of regulation must be devised and adopted to protect and augment the steelhead salmon runs and the trout supplies of these waters, and an investigation has been planned under the auspices of the two organizations uniting skill and material facilities on a large scale in the hope of meeting the situation.

FISHERY INVESTIGATIONS OF THE ATLANTIC AND GULF COASTS

Investigations of the changing abundance of the more important food fishes along the Atlantic coast and the causes of such changes with their implications as to remedial measures have proceeded with gratifying results. Fluctuations in the mackerel fishery continued to follow the principle of dominant year classes with a consistency that promises increased accuracy of predictions as more seasons are added to the experience upon which forecasts are based.

Much of the work at sea has been greatly handicapped through the lack of a fisheries research ship capable of operating trawls and

performing related duties in connection with the various problems. The rectification of this condition is urgent.

Continuation of the investigation of the shore fisheries of southern New England and the Middle Atlantic States has confirmed the view that fluctuation in yield of several important species is due to natural causes largely. In the case of scup and butterfish, dominance of the fishery by occasional exceptionally large broods is largely responsible for variation in the yield. In the case of squeteague, the causes have been found to be more complex and are not yet completely understood.

Investigations were continued on the seasonal occurrence of pelagic marine fish eggs and young fish at the entrance of Chesapeake Bay. During 1930–31 records of the new winter trawl fishery, which has developed recently off the Virginia and North Carolina coasts, were secured. This fishery is of special interest, since it provides employment for a number of otherwise idle northern vessels, supplies an important fresh-fish market in the seasons of scarcity, and opens to exploitation the species of fish formerly caught only in the summer season. In upper Chesapeake Bay an investigation of the striped bass or rockfish has been undertaken to study the life history and habits of the fish as a basis for regulations, which appear to be badly needed for the protection of the supply.

To provide further fundamental information as to the lives and habits of the important food fishes of the South Atlantic coast, studies on the development of the young of the shore species were continued at the Fisheries Biological Laboratory, Beaufort, N. C., where special facilities for such studies are available. One report on this subject was recently issued and another dealing with several species is nearing completion. At this station also improvements in the methods of feeding young diamond-back terrapin have been developed.

Although of commercial importance for a half century, the shrimp has achieved a place among the important fisheries only within the past 10 or 15 years. The growth of this industry has been so rapid and has reached such magnitude that grave fears as to the permanency of the supply have been entertained by the industry, and the investigation started during the last half of the fiscal year gives every promise of providing the necessary information for the enaction of regulatory legislation should that be necessary to insure continued productivity of the resource.

A special study is being made in Georgia of the effects of the shrimp trawl upon the food and game fishes of the area.

FISHERIES OF INTERIOR LAKES

Investigations of the commercial fisheries of the Great Lakes were continued during the fiscal year 1931. Three different types of research were carried on in the Great Lakes, viz, a study of the effect upon the fish stock of commercial fishing gear and studies of experimental gear designed to prevent the destruction and waste of undersized fish; investigations of the life histories of important commercial fish of the Great Lakes; and limnological surveys in Lake Erie to study the conditions of the environment affecting fish production.

Studies of the trap-net fishery in Lake Erie were completed during the year and recommendations will be offered for an improved type

of gear. Similar studies with gill nets were conducted in Green Bay, Lake Michigan, and in Lake Huron. In Lake Michigan a comprehensive program of experimental fishing with gill nets at numerous points typical of the entire lake has been continued, employing the fisheries motor ship *Fulmar*, in an effort to perfect fishing gear which will be effective for catching chubs without at the same time destroying a great number of immature lake trout. Experimental fishing-gear studies have contributed much information on the life histories of the important fishes taken, and such data accumulating as the field work progresses will be of material value in the drafting of fishery regulations by the various States.

Field studies on the international dispute concerning pike-perch fishing in Lake Champlain were completed during the fiscal year, and a report is in process of preparation.

In the Wisconsin lakes detailed studies of the rate of growth of various food and game fishes were made by the bureau's investigators in the hope of correlating these data with the great mass of limnological observations obtained by the Wisconsin Geological and Natural History Survey in a study of the factors affecting fish growth and reproduction.

FISHERIES OF THE PACIFIC COAST AND ALASKA

The results of fishery investigations in Alaska are utilized throughout the fishing season and from year to year in the formulation and in the prompt application of fishery regulations over the entire area in the interest of conservation. A knowledge of the routes of migration of the important salmon runs, enumeration of spawning fish passing weirs on their way to headwaters of streams for propagation, and the age composition of the various runs are essential to the bureau's program of regulation of the fisheries. During the fiscal year the third section of the report on the statistics of the Alaska salmon fishery was completed for publication. This report covers the statistics from earliest times to 1927 for the Prince William Sound and adjacent territory.

An important contribution to the knowledge of the biology of the Pacific herring was published during the year, and a second report on the fluctuations in the supply of herring in Prince William Sound has been prepared. The herring fishery has suffered depletion in restricted areas, and scientific information obtained from these studies has been of assistance in placing additional restrictions upon the fishery to prevent exhaustion in areas now productive.

During May, 1931, another regular biennial census of the razor-clam beds near Cordova, Alaska, was made to determine the state of the resource, in order that canning operations in that vicinity may be so regulated as to permit continued productivity of the beds.

In the United States, salmon investigations by the bureau have been restricted to the Columbia River. One new marking experiment dealing with land-locked salmon of that river was initiated during the spring of 1931, and the records of recovered fish resulting from previous marking experiments on other species were collected and analyzed.

FISH SCREEN AND FISH LADDER INVESTIGATIONS

The investigational work pertaining to the conservation of fish by means of screens and ladders has been continued without interruption. Field experiments with the electric screen have led to the adoption of simplified and improved apparatus. The highly satisfactory action of the electric screen in preventing upstream migrants from entering tail race waters was maintained during the past season. However, its effectiveness will never be 100 per cent, and there is a tendency on the part of the public to be apprehensive of the electric screen. On all new projects and wherever possible elsewhere the recommendation of the bureau is for the mechanical, revolving screen—a device which is unpatented and one which long use has proved to be entirely effective and reliable. The bureau continues to operate with success its electric screens in the Yakima country, where it is now impracticable to install mechanical screens. A development of the season's work was the discovery of the improvement that can be effected in leading migrating fish to by-pass channels by the use of lights. A survey has been made of fish-screen problems in Montana, and the bureau now has under construction a mechanical screen for the Jocko Canal and is preparing detailed plans and specifications for a mechanical screen (the largest ever constructed) on the Sun River Canal of the United States Reclamation Service.

In the fall of 1930 the bureau designed and constructed two concrete fish ladders on Government projects, these being located at Sprague River Dam in Oregon and at Wapato Dam in Washington. Both structures are similar in design to the successful ladder built by the bureau at Sunnyside Dam. During the winter the fish ladder requirements of the State of Maine were examined and reported on. In Idaho, special fishway problems received attention.

Considerable work has been done in connection with hydroelectric developments proposed or now under construction on streams supporting migratory fish. Applications for power licenses have been studied, field examinations made, and the proper fish-protective devices specified. Miscellaneous activities of the investigation have included engineering services in the preparation of designs for the water supply at the proposed new Butte Creek hatchery and for the new pumping equipment and distribution system at Clackamas hatchery.

AQUICULTURAL INVESTIGATIONS

Facilities for investigations in the interest of fish culture were materially increased during the fiscal year by improvements at the Fairport (Iowa) station, where pond facilities were nearly doubled. This station has become a prime factor in the bureau's fish-cultural activities, for the principles of black-bass culture which have been developed here are being generally adopted throughout the country at large wherever conditions are suitable. The output of fingerling bass which resulted as a by-product of the experimental work was of material aid in filling requests for fish for planting. Similar investigations to adapt the new principles to local conditions have been undertaken at several of the fish-cultural stations, and studies are

being conducted in the Upper Mississippi Wild Life and Fish Refuge, where it has been demonstrated that the sloughs and ponds adjacent to the Mississippi River can be used to produce black bass in considerable quantities.

Trout-cultural investigations were continued at the Pittsford (Vt.) experimental hatchery where feeding experiments have been under way for several years. Additional foods have been tested, the most striking results being obtained from the use of dried salmon eggs. Commercial fish meals were also employed and superior rations have been devised at material savings in cost over foods generally used in hatcheries. Breeding experiments to develop brood stocks of superior quality, which were begun several years ago, have been continued, and experiments in stocking local waters with black-spotted trout and Montana graylings have been notably successful. At this hatchery the diseases of trout were also studied.

An investigation which promises to become of considerable importance has been undertaken on the diseases of the sea herring of the coast of Maine.

An important part of the bureau's pathological studies has been conducted in numerous hatcheries throughout the eastern section of the United States.

SHELLFISH INVESTIGATIONS

The bureau's investigations of shellfish, aside from the razor-clam census referred to in connection with Alaska fishery investigations, include two distinct and totally unrelated projects. One deals with the oyster fishery and the cultivation of oysters on the eastern and western coasts of the United States as well as the Gulf area, and the other deals with the fresh-water mussels of the Mississippi River and the attendant problems of pollution.

Oyster investigations were conducted during the fiscal year 1931 in Southern New England, Chesapeake Bay, in various South Atlantic States, and on the Pacific coast. A study of causes of mortality of oysters in the lower Chesapeake Bay was finished and a preliminary report issued. The results of this work, which began in May, 1930, and which was carried out in cooperation with the Fisheries Commission of Virginia, show that the mortality of oysters in 1929–30 was caused by the concurrence of a number of unfavorable factors, namely, low oxygen tension in the water during the fall and winter of 1929, planting oysters on soft bottoms, and overcrowded conditions in some of the planted areas. The report stresses the necessity of employment of better oyster-cultural methods, and outlines the general policy for the development and maintenance of public reefs in the State of Virginia.

The main difficulty in the South Atlantic States is the overcrowding of oysters by a new crop of seed oysters that set on the old ones. It is planned to develop a method of control of setting whereby the crowded conditions on the reefs can be overcome. In several localities substantial areas of oyster bottoms were set aside for experimental purposes.

In New York and Connecticut the work on the method of control of starfishes and other enemies of oysters has been continued.

Numerous experiments made with different toxic substances have shown that positive results could be expected only with various copper salts.

In cooperation with the State department of fisheries there has been established at Olympia, Wash., a laboratory adapted for research on problems of the oyster industry of Puget Sound. An investigation of the effect of pulp-mill wastes on oysters, which has been carried on since 1929, has been completed and the report is in press. Present investigations deal primarily with the methods of cultivation and the biology of the native oyster. An investigator also was stationed on the Oregon coast to study local problems and to assist in developing improved practices in oyster culture.

Investigations of fresh-water pearl mussels, which provide raw material for the great American button industry, were conducted from laboratory headquarters at the University of Missouri and at various places along the Mississippi River and its tributaries from a floating laboratory loaned by the United States Army engineers and later purchased from them. These investigations are primarily aimed at the perfection of new methods of mussel culture devised in previous years' studies to propagate fresh-water mussels by means independent from fishes of the locality, which in nature must serve as hosts during the parasitic stage of the development of mussel larvæ. Immediate adoption of this method of culture on a commercial scale is prevented by the existence of sufficient pollution from industrial and domestic sources in the entire upper Mississippi River and in many of its tributaries to kill the young mussels. Accordingly, a critical study of this pollution factor has also been undertaken.

Surveys of other river systems, including those of Texas flowing directly into the Gulf of Mexico, have resulted in discoveries of considerable areas of river bottoms suitable for the propagation of mussels. A further survey is being organized to study the Mississippi River conditions south of Keokuk Dam and along the Ohio and Tennessee Rivers. In the course of this expedition with the floating laboratory, quantities of mussel spawn will be propagated and planted as suitable water areas are encountered. Plans have also been made to establish a mussel-rearing station at the bureau's fish hatchery at Fort Worth, Tex., for the stocking of waters in that region.

The War Department's program calling for the construction of a score of dams and a 9-foot ship channel in the upper half of the river has aroused the fears and protests of fishermen and sportsmen throughout the region. At the request of the War Department, therefore, the bureau undertook a survey of the area involved in order to ascertain what would be the probable effects upon the fish and mussel fauna of the canal and water storage projects. A detailed limnological survey was completed early in the fiscal year and a preliminary report was presented to the War Department summarizing the findings. This report pointed out that if pollution and silting of the river were first corrected, the canalization project would not be harmful, and indeed might be beneficial to fish life in that area.

ALASKA FISHERIES SERVICE

ADMINISTRATION OF FISHERY LAWS AND REGULATIONS

The execution of the laws and regulations for the conservation of the fisheries of Alaska was continued in accordance with the policy adopted when the White law of June 6, 1924, gave the Secretary of Commerce broad powers with respect to control of the time, place, and method of commercial fishing. As salmon yield greater wealth than any other natural resource of Alaska, particular attention was given to conservation measures affecting this fishery. Extreme fluctuations characterized the salmon runs in the calendar year 1930, necessitating sharp curtailment of commercial fishing in some places in order that no cyclical recurrence of the shortage might be caused by lack of seeding of the spawning beds. The Commissioner of Fisheries was in Alaska for a number of weeks during the active salmon-fishing season, giving personal attention to various fishery problems.

Revised fisheries regulations were issued December 18, 1930, to be effective in 1931. These have since been modified by a number of supplementary orders, including the temporary closing during the 1931 season of certain areas in southeastern and central Alaska which will eliminate the operation of some 150 traps. The boundary of the Yukon-Kuskokwim area has been extended and additional waters in that area have been opened to limited commercial fishing for salmon.

Twelve statutory employees and 232 temporary stream guards and special workmen were identified with the patrol of the fishing grounds in the calendar year 1930, in addition to the crews of 15 bureau vessels and 10 chartered boats. Launches were used by many of the stream guards stationed at the mouths of salmon streams and in other closed areas to prevent illegal fishing. As in the previous season, a supplementary patrol by aircraft was maintained from time to time, chiefly in southeastern Alaska during the weekly closed periods.

Much was accomplished in the improvement of salmon streams by the removal of obstructions that hindered the ascent of salmon to the spawning grounds. The destruction of predatory species of fish that feed upon young salmon was actively carried on in the Bristol Bay region. Territorial assistance in providing funds for these purposes was of material advantage. At its 1931 session the legislature appropriated $25,000 for continuance of this work during the next two years.

ALASKA SALMON HATCHERIES

At the Government hatcheries at Afognak and on McDonald Lake 33,731,790 red-salmon eggs, 18,019,470 pink-salmon eggs, 100,000 chum-salmon eggs, and 123,904 steelhead-trout eggs were collected in the calendar year 1930. Shipments totaling 16,262,776 pink-salmon eggs and 3,055,000 red-salmon eggs in the eyed stage were forwarded to Seattle for distribution. At the privately owned hatchery operated under the provisions of the Alaska fisheries act of June 26, 1906, 21,190,000 red-salmon eggs were collected.

SPECIAL STUDIES AND INVESTIGATIONS

Life-history studies of the Pacific salmons were continued, dealing primarily with the red-salmon runs of Bristol Bay, Karluk, Chignik, and Copper River, and the pink-salmon runs in southeastern Alaska. To develop further information regarding migration routes approximately 3,500 salmon, chiefly pinks, were tagged and released from traps in the vicinity of Cape Fox and on the east coast of Prince of Wales Island. Weirs to count the escapement of spawning salmon were operated in 26 typical salmon streams, of which 9 were in southeastern, 13 in central, and 4 in western Alaska. Investigations concerning the Alaska herring were also continued.

PRODUCTS OF THE FISHERIES

Salmon products comprised about 70 per cent in quantity and 84 per cent in value of the total output of the Alaska fisheries in the calendar year 1930. Approximately 93 per cent of the salmon products consisted of canned salmon, the pack amounting to 5,032,326 cases, or 241,551,648 pounds, valued at $29,694,898. As compared with the pack of the preceding year, the output of canned salmon in 1930 showed a decline of 6 per cent in quantity and 27 per cent in value. The heavy loss in value was attributable partly to the generally lower level of prices and partly to the shortage of red salmon. An unusually large proportion of the Alaska pack was made up of pink salmon, the price of which fell to but one-third of that of red salmon.

The quantity of herring products exceeded that of the preceding year, the gain being reflected entirely in the output of the pickled product. Prices on this commodity, however, as well as of meal and oil, showed a considerable decline, and the total value of herring products was the lowest since 1923. The halibut industry also was severely affected by economic conditions; as a result of curtailment of operations and of poor fishing in some localities there was a reduction of approximately 16 per cent in the quantity landed by the Alaska fleet, while the value declined 32 per cent from that of the preceding year. The production of clams and shrimps increased in both quantity and value. Cod fishing from shore stations decreased considerably, while whaling and virtually all of the minor fisheries were conducted on about the same scale as in 1929.

The total yield of the Alaska fisheries in the calendar year 1930 amounted to 370,990,360 pounds of products, valued at $37,679,049, as compared with an average of 370,353,764 pounds, valued at $48,042,667, for the 5-year period from 1925 to 1929, inclusive. The value of the 1930 catch to the fishermen was approximately $12,285,000, or about $4,297,000 less than in the preceding year. There were 27,568 persons employed in the various branches of the industry, as compared with 29,283 in 1929.

ALASKA FUR-SEAL SERVICE

GENERAL ACTIVITIES

An outstanding example of international cooperation is shown in the splendid results achieved under the convention of 1911 for the

protection and conservation of the North American fur-seal herd, which has its breeding grounds at the Pribilof Islands, Alaska. Since 1911 there has been a steady growth of the herd, numbering at that time about 125,000. There has also been a corresponding development of facilities for the expeditious conduct of the work at the Pribilof Islands.

Sealing operations in the season of 1930 included the taking and curing of sealskins and the marking and reserving of an adequate number of 3-year-old male seals for future breeding stock. For the first time there were no fall killings, as the plan has been adopted to preserve in cold storage such seal meat as may be required for food by the natives during the winter. Attention was given to the care of herds of blue foxes on St. Paul and St. George Islands and to the taking of fox skins.

Good progress was made during the year in the construction of new buildings, the erection of a dock at East Landing, and the extension of improved roads. The new by-products plant, which was begun in the spring of 1930, was completed; and equipment was installed in the season of 1931.

The service of the new tender *Penguin* was of very material advantage in the conduct of the bureau's work at the Pribilofs. A number of voyages were made to Seattle during the year, as well as frequent interisland trips and contacts with points along the Alaska Peninsula.

A staff of employees at the Pribilofs directed the work performed by resident natives and by temporary native workmen from the Aleutian Islands and the mainland who assisted with the work in the summer. The temporary labor is employed at a specified wage, but the Pribilof natives are virtual wards of the Government who are provided with the necessaries of life, including medical and educational aid, in return for their services. They receive cash payments also, at the rate of 75 cents for each sealskin and $5 for each fox skin taken, as well as some additional compensation for special services. At the close of the calendar year 1930 the native population of the Pribilof Islands numbered 375 persons.

The annual supplies for the Pribilof Islands were transported from Seattle, Wash., on the U. S. S. *Sirius*, through the cooperation of the Navy Department. The vessel carried a shipment of sealskins on the return voyage. Assistance was rendered also by the U. S. Coast Guard in patrolling waters frequented by the fur-seal herd.

SEAL HERD

Computations showed a total of 1,045,101 fur seals in the Pribilof Islands herd on August 10, 1930—an increase of 73,574 animals, or 7.57 per cent, over the corresponding figure for 1929.

TAKE OF SEALSKINS

In the calendar year 1930 there were taken on the Pribilof Islands 42,500 fur-seal skins, of which 34,382 were from St. Paul Island and 8,118 from St. George Island. This was an increase of 2,432 over the number taken in 1929.

MARKING RESERVED SEALS

In the calendar year 1930 there were marked and reserved for future breeding stock 6,539 three-year-old male seals, of which 4,918 were on St. Paul Island and 1,621 on St. George Island. Included in the reserve also were a large number of seals of this age class that were not taken up in the drives.

SALE OF SEALSKINS

Two public auction sales of fur-seal skins taken on the Pribilof Islands were held at St. Louis, Mo., in the fiscal year 1931. On September 15, 1930, there were sold 11,675 black-dyed, 8,307 logwood brown-dyed, and 99 miscellaneous unhaired and raw-salted skins for a gross sum of $357,990.25. In addition 1 confiscated skin dressed in hair brought $1.75.

At the second sale, held on March 30, 1931, 11,503 black-dyed and 9,568 logwood brown-dyed skins were sold for $453,699.75. At the same time 137 black-dyed and 33 raw-salted Japanese fur-seal skins sold for $3,172. These 170 skins were the United States Government's share of sealskins taken by the Japanese Government in 1929. There were also sold 2 confiscated fur-seal skins, which brought $1.

Special sales of sealskins authorized by the Secretary of Commerce in the fiscal year 1931 consisted of 110 black-dyed, 188 logwood brown-dyed, 50 raw-salted, and 16 miscellaneous skins for display purposes, at a total of $10,068.74. All were taken at the Pribilof Islands.

FOXES

The management of blue-fox herds on St. Paul and St. George Islands as an adjunct to the fur-seal industry gives work to the natives in the winter when sealing activities are at a minimum and is the source of no little revenue to the Government from the sale of the pelts.

Seven hundred and forty-five blue and 32 white fox skins taken in the season of 1929–30 were sold at public auction in the fiscal year 1931. The blue pelts brought $26,743 and the whites $992, a total of $27,735.

In the season of 1930–31, 211 blue and 24 white fox skins were taken on St. Paul Island and 678 blue and 2 white skins on St. George Island, a total of 915 skins. Fifty foxes on St. Paul Island and 313 on St. George Island were trapped, marked, and released for breeding purposes. The breeding reserve includes also a considerable number of foxes that were not captured during the season.

FUR-SEAL SKINS TAKEN BY NATIVES

Pursuant to the provisions of the North Pacific Sealing Convention of July 7, 1911, Indians under the jurisdiction of the United States and Canada took 2,832 fur-seal skins which were duly authenticated by officials of the respective Governments. Of these skins,

85 were taken by natives of southeastern Alaska, 450 by natives of Washington, and 2,297 by natives of British Columbia. Through the courtesy of the Interior Department the superintendent of the Neah Bay Indian Agency authenticated the skins taken by Indians of the State of Washington.

FUR-SEAL PATROL

A patrol of the waters frequented by the Pribilof Islands fur-seal herd was maintained by vessels of the United States Coast Guard, supplemented in the spring by two of the bureau's fishery patrol vessels which traversed the waters in the vicinity of Cape Flattery and off the coast of southeast Alaska.

PROTECTION OF SEA OTTERS, WALRUSES, AND SEA LIONS

No changes were made in the regulations previously issued for the protection of sea otters, walruses, and sea lions. 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.

BLACK BASS LAW ENFORCEMENT

With the transfer of Talbott Denmead, formerly assistant United States conservation officer of the Biological Survey, from the Department of Agriculture to the Department of Commerce to fill the newly created position of law enforcement officer, the new black bass law enforcement division of the bureau was formally inaugurated. The appropriation for the fiscal year 1932 will permit the bureau to employ one more full-time inspector, and perhaps several part-time ones, which positions will be filled in the near future.

With this small force it was found necessary to create the cooperative position of deputy black bass law inspector, without salary, appointees to be generally limited to regularly employed State fish and game protectors. While fully realizing that unpaid deputies are not always satisfactory, it is felt that much can be accomplished in this manner at present that could not be done in any other way.

The law enforcement officer has visited and held important conferences with State game officials and others in Pennsylvania, Minnesota, Wisconsin, Illinois, and the New England States relative to the enforcement of the black bass law. Inspections of Baltimore fish markets have been made regularly.

As the Federal statute is predicated on an infraction of State law, it is essential that the various State laws relating to closed seasons, limits, sale, and transportation of black bass be made readily available to all interested, including Federal and State officials, commercial fishermen, fish dealers, and sportsmen. Bureau officials have been steadily engaged for several months in a study of the game fish laws of the 48 States, and rapid progress has been made. The largest part of this rather complicated task is completed, and it will shortly be possible to issue in printed form a synopsis of the State game fish laws, along with the Federal black bass law and other data.

Numerous reports of alleged infractions of the Federal black bass law have been received from Kentucky, Maryland, Virginia, Arkansas, Alabama, Mississippi, and other States, but investigations in most instances disclosed no violations of the Federal statute. In several cases it was found that fish other than black bass were involved, and in others violation of State law could not be proved.

An excellent spirit of cooperation was received from the State fish and game departments, anglers, and others, and it is believed the law will be reasonably observed after it receives publicity and its provisions are fully understood. With this end in view numerous articles have been carefully prepared and published in fish and game magazines, the press, and other publications, covering the main features of the law, its aims and objects; addresses and radio talks by members of the bureau and others have explained the law, and about 2,000 copies have been distributed. The general correspondence resulting from this publicity has been large and covers many subjects relating to game fish, and the bureau has received many requests for advice and assistance in matters pertaining to game fish.

An excellent start has been made on the work in the three months since the inauguration of the division, and it enters the fiscal year of 1932 better prepared to carry out the provisions of the law.

VESSEL NOTES

The *Albatross II* was engaged throughout the year in scientific research work between Cape Sable, Nova Scotia, and Cape Hatteras, N. C., between the shore line and continental shelf. Oceanographic stations numbering 286 were made. Numerous 30 and 60 foot otter-trawl hauls were made. During the investigations there were tagged 352 cod, 280 haddock, 33 pollock, and flukes, sea bass, scup, butterfish, and croakers numbering 248 in all. At convenient times, between cruises, the vessel underwent various repairs at the Boston Navy Yard. The work was under the direction of O. E. Sette.

The steamer *Shearwater* was engaged in fish-cultural work at the Put in Bay (Ohio) station during the fall and spring months.

The steamer *Phalarope* was engaged as usual as a tender at the Woods Hole biological station.

The *Pelican* which was launched at Newport News, Va., last June is now at the Boothbay Harbor (Me.) station. It has been engaged throughout the year in fish-cultural activities.

The bureau's vessel *Fulmar*, a motor ship 102 feet long stationed at Charlevoix, Mich., was assigned to investigative duty with the Great Lakes scientific staff and has been fully equipped for experimental fishing. The vessel has been engaged in experimental work on Lake Michigan for the purpose of studying means of preventing the destruction of undersized and immature fish by commercial nets. Extensive biological data upon the life histories of these fishes and on problems of their conservation were obtained. The investigations continued from June to November, 1930, and were resumed again in May, 1931. Experimental fishing stations were occupied weekly throughout the season at numerous points distributed around the margin of the lake.

Sixteen vessels of the Alaska service cruised more than 140,000 nautical miles in the fiscal year 1931, as compared with 118,570 nauti-

cal miles in the previous year. The *Penguin* covered approximately 24,000 miles; the *Crane*, 15,000 miles; and the *Brant* and *Teal* each about 13,000 miles.

The *Penguin*, newest and largest of the bureau's Alaska vessels, was used chiefly as tender for the Pribilof Islands, although some incidental service was rendered the salmon-fishery investigations for two weeks in September. This vessel has proved a highly satisfactory addition to the Alaska fleet.

In southeastern Alaska the *Widgeon*, *Murre*, *Auklet*, and *Petrel* were engaged in fishery protective work 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 as follows: *Crane*, which had been on duty in the Alaska Peninsula region and had transferred seasonal employees to and from Bristol Bay; *Teal*, which patrolled waters of the Cook Inlet area during the summer; *Scoter*, engaged on Bristol Bay; *Blue Wing*, employed at Kodiak and Afognak Islands; and *Kittiwake*, which was in the Seward-Katalla district until September 10. The *Eider* and *Red Wing* were stationed in the Kodiak-Afognak district; the *Ibis* at Chignik; the *Merganser* in the Ikatan-Shumagin district; and the *Coot* on the Yukon River. The *Brant* was used in general supervisory work and made one cruise to the westward as far as Ikatan.

In addition to operations in connection with the fisheries in Alaska, the *Brant* was engaged for several weeks 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 *Widgeon* performed similar duty off the coast of southeastern Alaska.

Nearly all of the Alaska vessels were given a general overhauling during the winter, either at Seattle or at one of the Alaska ports. The *Blue Wing* was extensively remodeled and was equipped with the 50-horsepower gas engine formerly in the *Scoter*.

APPROPRIATIONS

Appropriations for the bureau for the fiscal year aggregated $2,631,885, as follows:

Salaries	$860,310
Miscellaneous expenses:	
Administration	4,400
Propagation of food fishes	574,000
Maintenance of vessels	169,500
Inquiry respecting food fishes	172,000
Fishery industries	87,000
Sponge fisheries	3,100
Construction of stations	265,000
Enforcement of black bass law	6,075
Protecting seal and salmon fisheries of Alaska	376,500
Upper Mississippi Wild Life and Fish Refuge	25,000
For improvements at the Fairport (Iowa) Biological Station	24,000
By-products plant, Alaska	65,000
	2,631,885

Very truly yours,

HENRY O'MALLEY,
Commissioner of Fisheries.

LIGHTHOUSE SERVICE

DEPARTMENT OF COMMERCE,
BUREAU OF LIGHTHOUSES,
Washington, July 1, 1931.

The honorable the SECRETARY OF COMMERCE.

DEAR MR. SECRETARY: In response to your request I furnish the following report on the work of the service during the past fiscal year:

MORE IMPORTANT ACTIVITIES OF THE LIGHTHOUSE SERVICE DURING THE YEAR

Work on the new Detour Light Station, under construction in Lake Huron at the entrance to the St. Marys River, has reached a point where a temporary light has been established, and the entire project is expected to be completed during the present season. Extensive changes are being made in the aids to navigation in the St. Marys River between Lakes Huron and Superior in connection with the improvements in certain channels. Temporary additional lights have been erected and new permanent aids are under construction. During the year the further breaking down of the cliff on which Cape Hinchinbrook Lighthouse, Alaska, stands has seriously endangered the station, and it is to be immediately rebuilt on a new site. Construction of a light station at Anacapa Island, Calif., has progressed, the nature of the site considerably handicapping the work. At Lehua Island, Hawaii, an automatic light has been established upon the highest point of the island and a pipe line installed from the landing. Other important improvements include the modernizing of additional fog-signal stations on the Great Lakes, by the replacement of old steam plants with new oil-engine power units and modern air-operated signals.

During the year three new lightships and one lighthouse tender were completed and placed in service. Four other tenders were under construction at the close of the fiscal year, one being nearly ready for delivery.

On June 30, 1931, there were 20,273 marine aids to navigation maintained by the Lighthouse Service, a net increase over the previous year of 711. During the year 205 new automatic lights on fixed structures were erected for marine use, and 63 lights were changed from attended to automatic. At the close of the fiscal year the total number of automatic lights on fixed structures for marine service was 1,835 (in addition to which there were several partially automatic lights). There were also 1,101 buoys with automatic lights, or a total of 2,936 automatic lights in the Lighthouse Service.

The effectiveness of the radiobeacon system has been increased during the year. As hereafter stated, 12 new beacons were established, including 2 in Alaska, making the total now 90. Of these, 68 automatically broadcast their signals hourly. Synchronization of stations in groups has been further carried out, largely eliminating interference. The system of synchronizing sound in air fog signals with radiobeacon signals has been further extended, and 16 such distance-finding stations are now in operation. Charts giving necessary data regarding radiobeacons have been revised and reissued.

Airways facilities were further extended during the fiscal year. Lighting installation was completed on about 2,283 additional miles of airways, including the following routes: Big Springs-Fort Worth, Kingsville-Houston, Kingsville-Waco, Norfolk-Washington, Columbus-Philadelphia, St. Louis-Indianapolis, Portland-Pasco, San Diego-Los Angeles, and Washington-Pittsburgh. The additional radio facilities established included 13 standard airway radio communication stations, 43 aural type and 2 visual-type radio-range beacons, a number of radio-marker beacons, and telephone-typewriter circuits aggregating over 3,000 miles. The visual system is being installed along the midcontinental airway for trial under actual service conditions. Because of changes in the routing and scheduling of air mail and passenger-carrying lines, considerable airway reconstruction was undertaken in order to provide more direct courses and larger intermediate landing fields suitable to the larger type of aircraft coming into general use.

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. Full information as to airways is to be found in the report of the aeronautics branch of the department.

AIDS TO NAVIGATION

During the year various improvements were made in the aids to marine navigation. Sixty-eight lights were changed from fixed to flashing or occulting; the illuminant of 10 lights was changed to incandescent oil vapor; the illuminant of 47 lights (including 18 lighted buoys) was changed to acetylene; the illuminant of 73 lights (including 2 lightships) was changed to electric incandescent; 12 radiobeacons were established; signals for distance finding were synchronized at 12 stations; and 4 diaphones and 1 tyfon were established at important fog-signal stations. Aids are discontinued from time to time as the original need for them ceases, the number being so discontinued during the past year totaling 894. As mentioned elsewhere, the total number of aids to marine navigation at the end of the year was 20,273.

In Alaskan waters 15 new aids were established, bringing the total number to 867. This includes 336 lights, 25 lighted buoys, 5 radiobeacons, 14 fog signals, 307 buoys, and 180 daymarks.

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 com-

mandants by means of allotments made from Lighthouse Service appropriations.

At the close of the year there were approximately 15,535 miles of lighted airways in operation and 357 miles of day routes, with 350 intermediate landing fields, 1,725 airway beacons, 48 standard airway radio-communication stations, 2 low-power broadcasting stations, 1 point-to-point station, 51 radio ranges, 24 radio-marker beacons, and a telephone-typewriter system of communications totaling 9,500 miles, with 178 telephone-typewriter stations. All of the equipment in operation at the radio-marker beacons has been fitted for radio-telephone transmission as well as for marker-beacon operation.

ENGINEERING CONSTRUCTION

The other important construction projects completed during the fiscal year, stated in order of districts, are as follows: Placing riprap around the foundations of Cape Cod Canal and Lynn Harbor Lights; protecting the ends of the sea wall at Liston Range Front Light Station, Del.; installing a radiobeacon at Cape Canaveral Light Station, Fla.; constructing a stone jetty to protect the lighthouse at Hillsboro Inlet, Fla., from erosion of the beach; installing an electrically operated siren at Southwest Pass Light Station, La.; placing two buoys and establishing three lights at Aransas Pass, Tex.; constructing a new power house at Rochester Harbor, N. Y.; replacing the steam whistle at Forty-Mile Point Light Station, Mich., by a type F diaphone; improving aids in the Columbia River; improvement of aids in Grays Harbor, Wash.; constructing a wood pile wharf and wood frame warehouse for the depot on Salmon Bay, Seattle, Wash.; building a permanent roadway from Drakes Landing to Point Reyes Light Station, Calif.; establishing Kilauea Point radiobeacon.

Important works in active progress at the end of the fiscal year are as follows: New structures for light and fog signal at Great Salt Pond, R. I.; installing new fog-signal apparatus at Delaware Breakwater, Del.; making hurricane damage repairs at Bulkhead Cut Range, Porter Bar, St. George Turn, and Apalachicola Range Lights, Fla.; constructing concrete piers, piling, and boathouse for Cleveland (Ohio) Light Station; construction of Rochester Pierhead tower, N. Y.; building complete light station on submarine site at Detour Reef, Mich.; erecting new structures for St. Marys River, Mich.; improving and consolidating aids in Chicago Harbor, Ill.; replacing steam fog signal at Sturgeon Bay Canal Light Station, Wis.; building new station at Cape Decision, Alaska; constructing a trail from Cape Hinchinbrook Light Station to English Bay; purchase of property adjoining the Seattle Lighthouse Depot, Wash.; establishment of light and fog signal at Bush Point, Wash.; improvement of the illuminating apparatus at Cape Flattery, Wash.

IMPROVEMENTS IN APPARATUS AND EQUIPMENT

The use of electricity for furnishing the current for lights and power to operate sound signals and other light-station equipment has materially increased during the fiscal year. The number of minor lights in which the current for the lamp and for the operation of a small flashing mechanism is furnished by a battery of primary cells

or dry cells has also increased. In most cases these replace oil post lanterns. This permits the consolidation of a group of lights under a single post light keeper. Several lighted buoys using electricity from dry-cell batteries have been established experimentally, with satisfactory results. At Aransas Pass radiobeacon station, in view of the availability of generators for charging storage batteries, 12-volt storage batteries were purchased for near-by minor electric lights, instead of using dry cells.

Experimental work has been in progress for some time to develop a lamp for use in masthead lights of lightships that will give a beam of light of sufficient vertical divergence so that the rolling of the vessel will not eclipse the light, with possible confusion as to the characteristic. As a result of these experiments, a lamp with special filament has been developed which appears to meet reasonably the requirements. This is a 1,000-watt, 110-volt lamp with 4-section filament. In a 500-mm. lens the lamp gives a candlepower of 16,000, with a vertical divergence of 15° at 10 per cent of the maximum beam candlepower.

A type of commercial lamp using a mantle similar to the standard i. o. v. lights has been installed at a number of minor stations having resident keepers. It has about twice the intrinsic brilliancy of a fifth-order improved oil lamp and consumes less kerosene. This lamp is a relatively inexpensive improvement for stations where it is impracticable or uneconomical to install a standard incandescent oil vapor lamp or an electric lamp.

Four sets of double ranges have been established in the St. Marys River to serve 2-way navigation in this important channel. These double ranges show white daymarks with white lights to approaching vessels and red daymarks with red lights over the vessel's stern. Acetylene is used as the illuminant in 400-mm. lanterns.

In an increasing number of cases green lights have been used to provide a distinctive light, and these have proved valuable where there have been conflicting white lights.

At Navassa Island Light Station a pipe line 2,500 feet long for conveying the acetylene gas from the landing to the light was installed to economize the time and labor of maintenance. This light can now be serviced in one day, a saving of two days over the old system which required transporting the acetylene tanks to the light, with a decrease in maintenance work of about 80 per cent.

A device has been developed for automatically sounding an alarm in the event that a radiobeacon is silent more than two continuous minutes during its period of operation. This device is particularly important in view of the present method of automatically operating beacons for scheduled periods during each day, permitting the keeper to attend to other duties, from which he is called by the alarm in case of trouble.

The low-power radiotelephone previously developed in the eleventh district has been materially improved. Equipment for five additional remote stations has been constructed. On recent tests conversations were carried on quite regularly at distances of 200 to 340 miles; however, the reliable range is considered to be much less than these distances.

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A signal controller governing all electric signaling operations at a station has been developed and one type is now in use at seven stations for synchronizing radiobeacon and sound signals. Other types now being constructed provide for the code of the radiobeacon and for flashing the light if electric.

As a result of the preliminary tests of synchronized radiobeacon and sound fog signals, additional stations have been fitted for distance finding; this system has met with the approval of navigators on the Great Lakes.

Fog signals having a diaphragm vibrated by compressed air or electricity are being further introduced and tested. A smaller fog-signal apparatus in which the diaphragm is operated electrically has also proved to be efficient as a minor fog signal. The replacement of worn-out steam fog-signal plants has continued.

The replacement of wooden spar buoys by special type steel buoys has continued. To insure greater safety, buoys in which tanks were housed inside the buoy body without tank pockets are being converted to the tank-pocket type, and buoys having portable gas connections on the inside of the buoy are being changed so that these are now on the outside of the buoy. To lessen danger of explosion in the buoy body, the standard plans of all lighted buoys have been revised to provide that hereafter all portable gas connections are to be on the outside of the buoy.

Die-lock chain has now been put in use on several vessels. Service tests of this chain have been satisfactory.

The astronomical clock has proved to be reliable and accurate and its use in connection with lighted aids is being gradually increased.

The airway standard electric code beacon was improved by substituting two 360° sections of half height in the lower lens element for the three 120° segments of full height used heretofore. This newly designed lens made possible the elimination of the three vertical astragals which obstructed the light beam to some extent. Mogul prefocus sockets were substituted in rotating beacons, code beacons, and course lights for the mogul screw socket for the purpose of assuring accurate focusing of the light units at all times. A new type boundary and obstruction light globe, considerably more efficient than the old type globe, was developed. The new globe has an improved vertical light distribution, in that the light transmitted to a pilot approaching at an altitude of 500 feet appears of equal intensity from a point of 500 feet altitude and 4,000 feet distant to a point directly over the light and 1,000 feet above it. The design of standard airway beacon towers has been improved to obtain a stronger and more rigid structure, and provision has been made for the installation of course lights or a code beacon by the addition of an auxiliary platform above the rotating beacon. Airport traffic signal lights have been developed so that colored light code signals can be flashed to pilots approaching landing areas. Time switches with special features for use with 3 kilovolt-ampere engine-alternator sets have been developed. A water-repellent and mildew-proof treatment has been developed for wind cone sock fabric which will increase the life of the material. New color schemes have been adopted for the painting of airway structures in order to provide suitable contrasts with ground colors prevalent in various sections of the country. New and

improved airway keepers' quarters have been designed. A special system of low-altitude side lighting was developed for use in the Columbia River Gorge, where extremely low ceilings prevail at times. The system adopted includes the use of stand-by lights fed by storage batteries during periods of commercial power outages. A new directional arrow, fabricated of galvanized metal, has been developed. This arrow can be moved readily, and as it is elevated several feet above ground will be visible above all but exceptionally heavy snowfall. A new wind indicator has been developed which shows by lighted wind tees both direction and velocity of the wind.

ADMINISTRATION

The general organization of the Lighthouse Service remained unchanged throughout the year. An adjustment of the limits between the thirteenth and fifteenth lighthouse districts was made in order that these districts might correspond with the Army Engineer districts. The limit of the fifteenth district has been extended to Grafton, Ill., to include the Missouri River.

Appropriations for the maintenance of the Lighthouse Service totaled $10,090,075 for the fiscal year 1931, and for special works $1,424,000. These amounts are exclusive of appropriations for airways, $7,944,000, of which $7,785,600 was allotted the airways division operated through the Lighthouse Service.

The following funds were also allotted from department appropriations: Printing and binding, $27,000; contingent expenses, $9,205.

The following amounts were received by the Lighthouse Service and turned into the Treasury: From proceeds of sale of Government property, $19,601.58; for rent of public buildings, grounds, etc., $4,091.31; forfeitures by contractors, $8,735.40; reimbursement for Government property lost, destroyed, or damaged, $6,226.58; work done for private interests by the Department of Commerce, $3,686.88; total, $42,341.75.

A pamphlet on the buoyage system of the United States was published during the year.

The act of March 3, 1931, modified previous legislation, authorizing the city of Fernandina, Fla., to use, for park purposes, certain portions of the Amelia Island Lighthouse Reservation. The act of February 26, 1931, authorized the Secretary of Commerce to continue the system of pay and allowances, including allowances for longevity, for officers and men on vessels of the Department of Commerce that was in operation on July 1, 1929.

Installation of the new accounting system, mentioned in the last annual report, was continued, and 10 districts are now making use of it; important simplifications were introduced in this system as originally planned, and in the cost keeping and classification of expenditures system, in order to restrict this work so that it could be done with existing personnel and to avoid a considerable additional expense. The accounting system will be extended to the other districts. It was designed by the General Accounting Office and is being introduced with the cooperation of that office.

PERSONNEL

On June 30, 1931, there were 5,754 persons employed in the marine work of the Lighthouse Service. This is an increase of 49 from the number in 1930. The number of persons in the airways division on June 30, 1931, was 2,117, making a total of 7,871 for both branches.

The United States Employees' Compensation Commission gives the number of reported cases of injury subject to compensation for the calendar year 1929, of employees of the Lighthouse Service, as follows: Cases resulting in death, 5; cases resulting in permanent total or partial disability, 4; cases of temporary total disability, 146.

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 113 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 specially meritorious, and some of the employees were specially commended by the Secretary of Commerce.

LIGHTHOUSE DEPOTS

The work of the Lighthouse Service requires adequately equipped lighthouse depots. Great importance is attached to the improvement of these supply stations, where conditions indicate the necessity. Substantial progress has been made during the fiscal year in the program of improvement for lighthouse depots. At Portland, Me., the construction of a complete new depot has been in progress during the year. Negotiations are in progress for the purchase of additional land adjoining the depot at Chelsea, Mass. A site for a depot has been purchased at Bristol, R. I. A project for enlarging the wharf area at the Woods Hole Depot, Mass., is under way. At Staten Island, N. Y., the machine shop has been transferred to the carpenter shop building, saving the expense of rebuilding the machine shop, and the carpenter shop has been placed in the foundry building; the old machine shop is used for needed storage space. At Edgemoor Lighthouse Depot, Del., work of rebuilding the north wharf is in progress. At Portsmouth Lighthouse Depot, Va., improvements are being made by providing steel bulkheads for the north dock and laying concrete pavement in the storehouse. Plans have been approved for improving the depots at Mobile, Ala., and Galveston, Tex. At Buffalo Lighthouse Depot, N. Y., a protected slip for vessels is under construction. At Seattle Lighthouse Depot, Wash., a wood pile wharf has been constructed, also a warehouse, and arrangements have been made for the purchase of land and a concrete building adjoining the present depot site. At Yerba Buena Depot, Calif., the reinforced concrete warehouse, machine shop, and power house have been completed. At Honolulu Lighthouse Depot, Hawaii, the concrete storehouse and shop buildings have been completed.

VESSELS OF THE LIGHTHOUSE SERVICE

The Lighthouse Service at the end of the fiscal year had in commission 113 vessels.

Three new lightships and one tender were completed. Four new tenders are now being constructed under contract; two will replace the small tenders *Birch* and the *Laurel*, and the other two will be additional tenders in the first and eighteenth districts.

During the year there were 38 cases of collision by vessels with aids to navigation, tenders, and other lighthouse property. Where the owners of such vessels were identified proper steps were taken to obtain payment for the damage caused. One claim also arose from damage by a lighthouse vessel to private property.

LIGHTHOUSE TENDERS

The new tender *Violet*, to replace the Holly, was completed and placed in commission in the fifth district. It is proposed to replace the *Azalea* in the second district with a duplicate of the *Violet*. Plans have been prepared for a tender to replace the *Pansy* in the third district, and for a small tender for the eighth district.

The conversion of the coal-burning tenders *Orchid* and *Sunflower* to oil burning is under way.

Lighthouse tenders during the year steamed a total of 495,466 miles on construction, maintenance, and inspection work, an average of approximately 8,692 miles for each tender. The total quantity of fuel consumed by tenders during the year was 40,584 tons of coal, 121,459 barrels of fuel oil, 16,954 gallons of gasoline, and 5,892 gallons of kerosene. The total cost of maintenance of tenders during the year was $2,220,018, exclusive of repairs which cost $286,545.

At the end of the year 56 tenders were in commission, 2 of which were undergoing repairs; of these 26 have radio compasses and 32 have radio communication.

The following tenders have been extensively overhauled during the year: *Heather*, *Ilex*, *Speedwell*, *Cypress*, *Magnolia*, *Sundew*, and *Hyacinth*.

The following was the number of tenders of the Lighthouse Service in commission on June 30 of the years specified, omitting vessels not having regular crews: 1910, 51; 1915, 45; 1920, 55; 1925, 55; 1930, 55; 1931, 56.

There are, in addition, 11 small depot tenders without regular crews.

The tender *Laurel* was sold on March 24, 1931, for $2,165, being beyond economical repair.

LIGHTSHIPS

Lightships are maintained on 44 stations. At the end of the year 56 lightships were in commission, including 12 relief ships. They averaged 262 days on station per vessel. The total cost of maintenance of lightships during the year was $1,165,947, exclusive of repairs which cost $178,009.

The remaining three of the six Diesel electric-propelled lightships contracted for were completed and placed in commission. *No. 115* on Frying Pan Shoals Station, N. C., July 18; *No. 116* on Fenwick Island Station, Del., November 12; and *No. 117* on Nantucket Shoals Station, Mass., May 4.

The following was the total number of lightships on June 30 of the years mentioned: 1910, 68; 1915, 66; 1920, 62; 1925, 59; 1930, 57; 1931, 57. Lightship stations: 1910, 51; 1915, 53; 1920, 49; 1925, 46; 1930, 44; 1931, 44.

Of the present lightships 46 have propelling machinery, 10 are provided with sail power only, and 1 has no means of propulsion. One lightship has no crew. The lightship stations may be classified as outside, 28; inside, 9 (all in the second and third districts); and lake, 7.

Three old lightships were sold during the year, being beyond economical repair; *No. 1* on November 24, 1930, for $251; *No. 5* on January 29, 1931, for $251; and *No. 67* on December 30, 1930, for $873.

Very truly yours,

GEORGE R. PUTNAM,
Commissioner of Lighthouses.

COAST AND GEODETIC SURVEY

DEPARTMENT OF COMMERCE,
COAST AND GEODETIC SURVEY,
Washington, July 1, 1931.

The honorable the SECRETARY OF COMMERCE.

DEAR MR. SECRETARY: In response to your request I furnish the following report on the work of the bureau during the past fiscal year.

HYDROGRAPHIC AND TOPOGRAPHIC WORK

During the year topographic and hydrographic surveys, including the triangulation necessary to control them, were made on the Atlantic, Gulf, and Pacific coasts of the United States, in Alaska, Hawaii, and the Philippines. A brief outline of and statistics for the various projects follows:

Atlantic coast.—The principal project on the Atlantic coast was the continuation of the survey of Georges Bank, started during the latter part of the previous fiscal year to meet demands from both the shipping and fishing industries for modern detailed charts of that locality. Work was carried on until October by the survey ships *Oceanographer* and *Lydonia* and resumed in May by the *Hydrographer*, *Oceanographer*, *Lydonia*, and *Gilbert*. This was the first assignment of the new *Hydrographer*.

During the winter months the *Oceanographer* was engaged on surveys in the Gulf of Mexico, east of Pensacola, Fla., while the *Lydonia* and *Gilbert* were engaged on offshore surveys southeast of Cape Canaveral, Fla.

During the first part of the year, the *Natoma* was engaged in making surveys of the Hudson River, between Fort Washington and Tarrytown, N. Y. Nine topographic sheets of this locality were compiled from aerial photographs. These surveys were undertaken primarily to obtain the data necessary for the construction of two large-scale anchorage charts required by the United States Navy. During the last half of the year the *Natoma* was engaged in making surveys in the vicinity of Port Royal Sound and Skull Creek, S. C. This work was done in cooperation with the United States Engineers and the Lighthouse Service.

The party on the *Ranger* was engaged on surveys in the vicinity of Fort Pierce and Biscayne Bay, Fla., until February, at which time the ship was decommissioned. The compilation of topographic sheets from aerial photographs of the Florida east coast from Ormond to Key Largo was completed, using the control furnished by the party on the *Ranger*.

During a part of the year a shore party was engaged in making surveys between Galveston Bay and Houston, Tex., necessary for the construction of large-scale charts of that locality.

A shore party was engaged during part of the year in the execution of control surveys in New York Harbor and vicinity.

A field examination was made and manuscript partly prepared for a new edition of the Inside Route Pilot, New York to Key West, and work was started on a field examination for a new edition of the Alaska Coast Pilot, Part I.

Pacific coast.—The party on the ship *Guide* continued the surveys started near the end of the last fiscal year along the coast of Washington, north of Cape Elizabeth. The work was carried northward to Cape Flattery. This project extends offshore to the 1,000-fathom curve and includes a survey of the important approaches to Juan de Fuca Strait and portions of the Strait never adequately surveyed.

A shore party completed new inshore topographic and hydrographic surveys on the California coast, from Havens Anchorage southward to the proximity of Bodega Bay.

Control surveys were extended from Half Moon Bay southward to Monterey Bay, Calif., preparatory to taking up detailed inshore and offshore surveys along that section of the coast.

A shore party was engaged during a portion of the year in making new surveys of the southern portion of San Francisco Bay. In connection with this project, the region was photographed for the Survey by the United States Army Air Corps.

Alaska.—The party on the ship *Surveyor* continued surveys along the west coast of Kodiak Island. Work was extended during the 1930 season from Cape Ikolik southward through Sitkinak Strait and included a survey of Olga Bay. This, combined with the previous season's work, completed the survey of Alitak Bay and tributaries. During the present season, surveys are being extended eastward along the south coast of the island toward Sitkalidak Strait. These will include the western approaches of that strait as well as the eastern approaches to Sitkinak Strait. The results of last season's work will be shown on chart No. 8537, scale 1:80,000.

The party on the *Discoverer* continued surveys along the south coast of Kenai Peninsula, westward from Aialik Bay. These were extended offshore to the 100-fathom curve and as far west as Port Dick. They included a detailed survey of that bay, as well as of Nuka Island Pass. The results of the work are now being applied to chart No. 8530, which area has now been entirely surveyed. During the present season, this party is employed in extending the surveys southwestward across the passages between the Kenai Peninsula and Afognak Island. Detailed surveys will be made of Windy Bay, the area around the Barren Islands and around the west, north, and east side of Shuyak Island. The season's work will clear up several reported dangers to navigation in the passage between Shuyak Island and the Barren Islands.

The party on the *Explorer* continued the work in Behm Canal, started during the latter part of the fiscal year 1930. More than half of the waterway has been surveyed in detail, and it is expected that the remainder will be completed during the present season.

Hawaiian Islands.—During the summer months, the party on the *Pioneer* continued work on the project which calls for a survey of the chain of shoals, reefs, and islets extending from the main group of the Hawaiian Islands westward for a distance of 2,000 miles to Midway Island. The importance of this area, never properly charted, lies in the fact that this region is traversed by the principal trans-Pacific steamer track. During the winter this party was engaged on surveys in the vicinity of Molokai, Lanai, and Maui Islands.

Philippine Islands.—The parties on the ships *Pathfinder*, *Fathomer*, and *Marinduque* continued work throughout the year on the north and east coasts of Luzon Island, west coast of Palawan Island, and in the Sulu Archipelago.

Hydrography, topography, and triangulation accomplished

Locality	Hydrography			Topography		Triangulation (second and third order)		
	Miles of sounding lines	Area in square miles	Number of soundings	Length of shoreline surveyed in miles	Area surveyed in square miles	Length of scheme in miles	Area covered in square miles	Number of geographic positions determined
Georges Bank, Mass.	8,689	11,438	40,047					
Long Island Sound, N. Y. & Conn.	[1] 27	[1] 89	[1] 751			18	114	98
Hudson River, N. Y.	795	15	11,444	95	38	16	22	30
Hudson River, N. Y. (air-photo reduction)				17	9			
New York Harbor, N. Y.						35	100	250
Baltimore Harbor, Md.				4	1		1	7
Port Royal Sound, S. C.	1,461	108	49,827	91	12	66	306	70
Cape Canaveral, Fla.	1,605	1,382	7,957					
Fort Pierce, Fla.	212	102	2,509					
Biscayne Bay, Fla.	753	86	26,285	43		45	231	67
East Coast, Fla. (air-photo reduction)				734	505			
St. Andrews Bay, Fla.	36	4	1,361					
East of Pensacola, Fla.	554	300	6,028			12	68	9
Houston Ship Channel, Tex.	359	25	16,812	109	49	29	71	105
San Francisco Bay, Calif.	1,238	110	63,386	48	73	20	121	75
Halfmoon Bay to Monterey Bay, Calif.						79	267	124
Havens Anchorage to Bodega Bay, Calif.	543	41	12,089	73	20	5	7	7
Cape Elizabeth to Cape Flattery, Wash.	6,966	4,743	48,721	51	26	54	212	27
Behm Canal, Alaska	2,903	219	42,978	394	255	58	96	94
Kenai Peninsula, Alaska	5,115	2,614	44,154	142	208	178	1,900	57
Kodiak Island, Alaska	6,811	1,430	91,755	310	331	71	420	74
Oahu to Laysan Island, Hawaiian Islands	14,696	64,530	33,180	5	2		1	11
Molokai, Maui, and Lanai islands, Hawaiian Islands	3,665	2,451	43,620	9	1			6
North and east coasts, Luzon Island	4,383	1,365	53,733	83	130	68	600	15
West coast, Palawan Island	8,696	747	134,271	169	76	46	364	51
Sulu Archipelago	6,003	744	49,758	91	49	12	296	29
Manila Bay, Luzon Island	186	5	1,378	4				1
Total	75,696	92,548	782,044	2,472	1,785	812	5,197	1,207

[1] Wire drag.

GEODETIC WORK

Locality	Length of scheme	Area covered
Triangulation, first-order:	*Miles*	*Sq. mi.*
Wisconsin, La Crosse to Fond du Lac arc	150	1,650
Nebraska, Iowa, and Illinois, forty-second parallel arc	550	6,150
Illinois, Cairo to Belleville arc	125	1,625
Illinois, Kentucky and Tennessee, Cairo to Nashville arc	160	1,700
Missouri, Cairo to Poplar Bluff arc	110	1,000
Arkansas, Louisiana, and Texas, ninety-fourth meridian arc	350	4,000
Louisiana and Mississippi, Shreveport to Forest arc	240	2,100
Alabama, Mississippi, Louisiana, and Texas, Gulf Coast arc	700	5,900
Illinois, Missouri, and Iowa, Mississippi River arc	290	2,900
Triangulation, first-order—Contd.		
North Carolina, Virginia, and Tennessee, revision	85	3,750
Texas, ninety-eighth meridian-Laguna Madre connections	30	215
New Mexico and Texas, Mexican connection	70	2,000
California, Monterey Bay to Mariposa Peak	35	1,050
Total	2,895	34,040
Base lines, first-order:		
Nebraska, Rogers	7.8	-------
Iowa, Liberty	6.1	-------
Illinois, La Salle	5.1	-------
Illinois, Belleville	4.2	-------
Kentucky, Pembroke	6.1	-------

GEODETIC WORK—Continued

Locality	Length of scheme	Area covered
Base lines, first-order—Continued.	*Miles*	*Sq. mi.*
Georgia, Hamilton	8.7	-------
Alabama, Union	10.8	-------
Mississippi, Forest	8.7	-------
Louisiana, Monroe	5.6	-------
Louisiana. Shreveport	6.5	-------
Arkansas, Ashdown	9.2	-------
Mississippi, Pass Christian	3.7	-------
Louisiana, Schriever	3.7	-------
Louisiana, Baldwin	3.8	-------
Louisiana, Lake Arthur	6.8	-------
Texas, Winnie	10.7	-------
Texas, Palacios	10.0	-------
California, Santa Ana	1.0	-------
Total	118.5	-------
Reconnaissance, first-order triangulation:		
Arkansas, Louisiana, and Texas, ninety-fourth meridian arc	300	3,200
Louisiana and Mississippi, Shreveport to Forest arc	240	2,100
Alabama, Mississippi, Louisiana, and Texas, Gulf Coast arc	700	5,900
Illinois and Missouri, Mississippi River arc	75	675
Illinois, Missouri, Iowa, Wisconsin, and Minnesota, Mississippi River arc	420	4,600
Texas, ninety-eighth meridian-Laguna Madre connections	30	215
New Mexico and Texas, Mexican connection	70	2,000
California, Monterey Bay to Mariposa Peak	35	1,050
California, San Joaquin Valley	325	9,500
Nevada and Oregon, Reno to Lakeview arc	175	4,500
Montana, Wyoming, and Colorado, Billings to Grand Junction arc	350	11,750
Total	2,720	45,490
Leveling, first-order:		
Warsaw, Ind., to Leipsic, Ohio	103	-------
Highlands to Pleasantville, N. J., including spur lines to Beach Haven and Barnegat City	117	-------
Eugene to Redmond, Oreg	116	-------
Rainier, Oreg., to Kelso, Wash	14	-------
Sea Isle Junction to Camden, N. J.	101	-------
Elkhart, Ind., to Walton, Mich	302	-------
Pendleton to Mount Vernon, Oreg	122	-------
Rockton, Ill., to Escanaba, Mich	340	-------
Mount Vernon to Vale, Oreg	135	-------
Grayling to Detroit, Mich	203	-------
Hebo to Salem, Oreg	62	-------
Drain to Reedsport, Oreg	57	-------
Minneapolis, Minn., to Glasgow, Mo	579	-------
Leveling, first-order—Continued.	*Miles*	*Sq. mi.*
Ottumwa to Muscatine, Iowa	81	-------
Mount Vernon to Arlington, Oreg	159	-------
Astoria to Newport, Oreg	158	-------
Newport to Albany, Oreg	71	-------
Ladysmith, via Wisconsin Rapids, to Green Bay, Wis	198	-------
Wisconsin Rapids to La Crosse, Wis	109	-------
Jackson, Ky., to Morristown, Tenn	244	-------
Murfreesboro, Tenn., to Stevenson, Ala	90	-------
Lathrop to Bakersfield, Calif	232	-------
Farwell to Sweetwater, Tex	224	-------
Moccasin Gap to Roanoke, Va	186	-------
Vicinity of San Pedro, Calif. (revision)	2	-------
Washington to Bellevue, D. C	5	-------
Niland, via El Centro, to Jacumba, Calif. (rerun, earthquake investigations)	85	-------
El Centro, Calif., to Yuma, Ariz. (rerun, earthquake investigations)	60	-------
Seligman, Mo., toward Kensett, Ark	183	-------
Nashville, Tenn., to Florence, Ala	130	-------
Grants Pass, Oreg., toward San Francisco, Calif	180	-------
Harpers Ferry, W. Va., to Harrisburg, Pa., (rerun along old transcontinental line)	106	-------
Arcata to Redding, Calif	152	-------
Josephine to Blairsville, Pa	13	-------
Clarksburg to Saltsburg, Pa	12	-------
Butler to Gallery, Pa	20	-------
Abilene to Del Rio, Tex	330	-------
Philadelphia, Pa., to Lewes, Del., including numerous spur lines (part)	175	-------
Crescent City, Calif., to Reedsport, Oreg	188	-------
Winnemucca, Nev., to Crane, Oreg. (part)	80	-------
Brady to San Antonio, Tex	13	-------
Total	5,737	-------
Leveling, second-order:		
Tullahoma to Rockwood, Tenn	122	-------
Medford to Crater Lake, Oreg. (part)	34	-------
Total	156	-------
Summary:		
First-order triangulation	2,895	34,040
First-order base lines	118.5	-------
First-order triangulation, reconnaissance	2,720	45,490
First-order leveling	5,737	-------
Second-order leveling	156	-------

The past year has been a notable one in the geodetic history of the Survey. Beginning July 1, 1930, a much larger appropriation became available for the geodetic work and, in consequence, great strides have been made during the past year toward filling up the gaps which exist in the control nets. In fact, at the present rate of progress the

first and second order control surveys will be completed in 10 or 11 years.

The plan being followed is to have first-order arcs of triangulation and lines of levels spaced at intervals of about 100 miles with cross arcs and lines for purposes of strengthening the nets and for use in adjustments. The intermediate areas will be crossed by arcs of second-order triangulation and by lines of levels of the second order.

Nearly 2,900 miles of triangulation were executed during the past year, the greater part of which was designed to supplement the first-order net of the eastern half of the country to the point where an adjustment of the net could be made. Arcs were extended from La Crosse to Fond du Lac, Wis., along the forty-second parallel in Nebraska, Iowa, and Illinois; from Nashville, Tenn., through Cairo to Belleville, Ill.; from Cairo, Ill., to Poplar Bluff, Mo.; along the ninety-fourth meridian in Arkansas, Louisiana, and Texas; from Shreveport, La., to Forest, Miss.; and along the Gulf coast from Mobile, Ala., to Corpus Christi, Tex. These arcs completed all the triangulation necessary for the adjustment of the net, and at the close of the fiscal year the office work of the adjustment was being vigorously prosecuted. It is expected that this adjustment will be completed during the fiscal year 1932 and that, as rapidly as possible, the resulting data, which will be final, will be made available in the form of published pamphlets.

The increased appropriation carries a provision that additional personnel could be employed for the adjustment and computation of the field observations and for the preparation of the resulting data for publication. This has assisted materially in advancing the time at which the data could be made available in final form.

A notable piece of cooperative work, during the fiscal year 1931, was the execution of an arc of first-order triangulation along the Mississippi River, from Chester, Ill., to St. Paul, Minn. This work was undertaken at the request of the Chief of Engineers of the United States Army and funds of that organization were transferred to the Coast and Geodetic Survey to pay the field expenses of the work in question. The work was started early in May at Chester, Ill., and, by the end of the fiscal year, had been carried to the vicinity of Davenport, Iowa. Frequent connections were provided to the triangulation stations of the Mississippi River Commission. When the triangulation has been completed, which should be early in September, 1931, it will be possible to fit the detailed triangulation of the Mississippi River Commission into the first-order scheme executed by the Coast and Geodetic Survey.

The Survey also cooperated with the Corps of Engineers by running a line of first-order levels between Philadelphia, Pa., and Lewes, Del., with some spur lines extending from the main line to points of importance in engineering work. Part of the field expenses of this line of levels were defrayed from funds transferred by the Corps of Engineers. The work was nearly completed by the end of the fiscal year.

A short arc of triangulation was extended from Monterey Bay to Mariposa Peak in California for use in detecting possible earth movements. The arc is similar to the two run last year and is a combination of a large first-order scheme with a smaller connected second-order scheme running through it.

In continuation of the plan to place all the triangulation of North America on the same datum, a connection was made between the Mexican and United States triangulation nets in the vicinity of El Paso, Tex. The stations in United States territory were occupied by an officer of the Survey, while observations at the Mexican stations were made by a representative from the Bureau of Geographical and Climatological Research.

Seventeen base lines were measured to control the lengths in the new triangulation east of the ninety-eighth meridian. One of these base lines is in Nebraska, 1 in Iowa, 2 in Illinois, 1 in Kentucky, 1 in Georgia, 1 in Alabama, 1 in Arkansas, 2 in Mississippi, 5 in Louisiana, and 2 in Texas.

A base line, 1 mile in length, was measured near Santa Ana, Calif., for use in connection with experiments, to determine the velocity of light, conducted by the late Dr. A. A. Michelson.

A number of Laplace stations needed for the adjustment of the eastern triangulation net were provided by an astronomical party, which made observations for longitude, latitude, and azimuth in 14 States in the central and southern parts of the country.

About 6,000 miles of first and second order leveling were run during the year. This work is located in various parts of the country and distributed through 24 States.

The international variation of latitude station at Ukiah, Calif., was continued in operation during the year and the station at Gaithersburg, Md., was being repaired in preparation for the resumption of observations during the coming fiscal year.

TIDE AND CURRENT WORK

The work during the fiscal year 1931 included the operation of a number of primary tide stations for the purpose of furnishing general tidal control for the various regions, numerous secondary tide stations for use in connection with hydrographic surveys, special tide and current suveys in Narragansett Bay and Block Island Sound, and additional current observations at a number of localities.

Primary tide stations.—Throughout the fiscal year, 27 primary tide stations were in operation, namely, 14 on the Atlantic coast, 3 on the Gulf of Mexico coast, 6 on the Pacific coast, 2 in Alaska, and 2 in the Hawaiian Islands. Three new stations were established during the year—one at Newport, R. I., in October, 1930, on a cooperative basis with the public works officer, Naval Training Station, the second in December at Savannah, Ga., in cooperation with the United States Army Engineers, and the third in April, 1931, at Washington, D. C.

The observations secured from these stations furnished essential data for hydrographic control, the determination of accurate datum planes, reducing the results of short series of observations to mean values, furnishing information necessary for court cases, and for determining secular changes in relation of land to sea.

Eleven of the 30 primary tide stations in operation at the close of the year were handled on a cooperative basis with other Federal agencies, eliminating the expense for observers. The following list gives their location, cooperative stations being indicated by an asterisk (*):

Eastport, Me.
Portland, Me.
Portsmouth, N. H.*
Boston, Mass.
Newport, R. I.*
New York, N. Y.
Atlantic City, N. J.
Philadelphia, Pa.
Washington, D. C.
Baltimore, Md.
Annapolis, Md.*
Hampton Roads, Va.*
Charleston, S. C.
Savannah, Ga.*
Mayport, Fla.*
Daytona Beach, Fla.
Jacksonville, Fla.*
Key West, Fla.
Pensacola, Fla.
Galveston, Tex.
La Jolla, Calif.
San Francisco, Calif.
Los Angeles, Calif.*
San Diego, Calif.*
Astoria, Oreg.
Seattle, Wash.
Ketchikan, Alaska.
Seward, Alaska.
Hilo, Hawaii*
Honolulu, Hawaii.*

With the assistance of the United States Army Engineer Office, an additional cooperative station will shortly be established at Miami Beach, Fla.

Secondary tide stations.—Records were received from Prospect Harbor, Me., Fort Lauderdale, Fla., Santa Barbara, Calif., and Cordova, Alaska.

Sufficient information having been obtained for the present from the gages located at Prospect Harbor, Me., Everglades, Fla., and Ocean City, Md., these stations were discontinued January 7, April 16, and May 26, respectively. During the year gages were established in Richmond Inner Harbor, Calif., in the inner harbor of Los Angeles, Calif., Newport Beach, Calif., and Rockland, Me.

Basic bench marks.—Arrangements have been completed for the installation of a basic bench mark in the city park at Portland, Me., and, as soon as certain improvements are made, one will be established in The Battery, New York City.

These marks are now located at the following cities:

Boston, Mass.
Atlantic City, N. J.
Baltimore, Md.
Norfolk, Va.
Charleston, S. C.
Key West, Fla.
Pensacola, Fla.
La Jolla, Calif.
San Francisco, Calif.
Seattle, Wash.

Inspection of tide stations.—The following tide stations were inspected during the fiscal year and levels run between tide staff and bench marks:

Eastport, Me.
Prospect Harbor, Me.
Portland, Me.
Portsmouth, N. H.
Boston, Mass.
Newport, R. I.
Ocean City, Md.
Annapolis, Md.
Hampton Roads, Va.
Mayport, Fla.
Jacksonville, Fla.
Daytona Beach, Fla.
Fort Lauderdale, Fla.
Key West, Fla.
Everglades, Fla.
San Diego, Calif.
La Jolla, Calif.
Santa Barbara, Calif.
Honolulu, Hawaii.

Tide and current surveys.—The tide and current survey of Narragansett Bay and Block Island Sound was completed during the year. Approximately 150 current and 25 tide stations were occupied by this party. At each current station the half-hourly velocities and directions of the surface current were observed by means of the current pole and line, and the velocities at three subsurface depths measured by current meters. The data secured, together with all other avail-

able observational information for that area are being reduced, compiled, and correlated for publication.

Current observations in the vicinity of the Rockland, Me., trial course were undertaken by the Coast and Geodetic Survey and the Navy Department, with current meter, pole, surface float and subsurface float. Sixteen days of continuous observations were secured.

During June, a tide and current survey of Buzzards Bay was begun where half-hourly velocities and directions of currents will be observed at fully 100 locations.

Miscellaneous current observations.—During the year hourly current observations were made on the Hen and Chickens, Brenton Reef, and Vineyard Sound Lightships. From June to December, 1930, observations were made on the Cornfield Point Lightship. Current observations were also obtained in the Hawaiian Islands by the ship *Pioneer*. These observations were made at anchorage and, when practicable, covered periods of one or two days in the important channels.

Density and temperature observations.—At 20 of the primary tide stations, daily density and temperature observations were taken by the observer in connection with his other duties. Similar observations were taken in connection with the special tide and current surveys.

Summary of tide and current records received.—The following is a summary of tide and current records received during the year:

Records received	Stations	Months	Days
Automatic tide gage	134	585	
Current	154		1,437
Level	122		
Density and temperature	169	240	159

Cooperation.—Continued encouragement is given to cooperation with other organizations in carrying on tide and current work because of the mutual benefits derived. At a number of tide stations, the Survey provides instruments and instructions, and the cooperative agency the shelter and an observer to give daily attention to the tide gage. Such stations are subject to the usual inspection. Copies of the records are available to both organizations, the original usually being filed in the archives of this office. Another form of cooperation consists in the exchange of tide and current data obtained independently by different organizations.

Cooperation with the United States Army Engineers has been especially valuable because of the need of both organizations for tide and current data. During the past year, tide stations at Jacksonville and Mayport, Fla., were so maintained with the office of the district engineer at Jacksonville, and a similar station at Fort Screven, Savannah, with the office of the district engineer at Savannah.

Valuable tide information was also received from the Navy, and stations were maintained cooperatively with that department at at Portsmouth, N. H., Newport, R. I., Annapolis, Md., Hampton Roads, Va., and San Diego, Calif.

A tide station has been maintained at Honolulu, Hawaii, with the surveyor of the Territory of Hawaii, and one at Hilo, Hawaii, with the United States Geological Survey.

Other cooperative tide stations include one each at Cordova, Alaska, by the Chamber of Commerce; Los Angeles, Calif., by the Harbor Department; Prospect Harbor, Me., by Henry S. Shaw; Fort Lauderdale, Fla., by the city authorities; Everglades, Fla., by the Florida Railroad & Navigation Corporation; Richmond Inner Harbor, by the Berkeley Water Front Co., San Francisco; and Newport Beach, Calif., by the city engineer.

MAGNETIC AND SEISMOLOGICAL WORK

Magnetic stations occupied during the fiscal year

Alaska	20	Nevada	5
Arizona	1	North Carolina	8
California	5	Oregon	6
Colorado	4	Philippine Islands	14
Florida	5	Porto Rico	1
Hawaii	2	Utah	2
Idaho	7	Washington	10
Kansas	6	Wyoming	2
Maryland	2		
Montana	5	Total	105

During the first half of the year, the object of the magnetic work was to complete the occupation of repeat stations in order to determine the change of the earth's magnetism with lapse of time for the publication Magnetic Declination in the United States in 1930. Incidentally, a number of stations which had ceased to be available were replaced, to meet the needs of local surveyors. With the cooperation of the Department of Development and Conservation of the State of North Carolina, all defective stations in that State are being replaced or put in good condition in anticipation of a new edition of the publication Magnetic Declination in North Carolina.

Continuous photographic records of variations of the magnetic elements were made at the five magnetic observatories, together with the necessary observations, to convert these into absolute values. At Cheltenham, Md., field instruments have been standardized. At Tucson, Ariz., atmospheric electric observations have continued, and earth current observations have been in progress since April with the cooperation of the Mountain States Telephone & Telegraph Co. and the Carnegie Institution of Washington. At Sitka, Alaska, preparations have been made for replacing the observatory instruments, and auroral observations have been continued. Magnetic information was furnished the Alaska Agricultural College and School of Mines at Fairbanks, Alaska, in connection with the auroral program at that institution established through a grant from the Rockefeller Foundation.

Seismology—Seismographs were operated continuously at the Sitka and Tucson observatories, at Honolulu in cooperation with the University of Hawaii, and at Chicago in cooperation with the University of Chicago. Two Wenner seismometers have been established at San Juan, where they have been in operation since January 1. At Sitka, preparations have been made for the installation of Wenner seismometers early in the next fiscal year. Seismographs have been installed at the University of South Carolina, Columbia, S. C., and at the Montana State College, Bozeman, Mont., with operation on a cooperative basis.

The systematic collection of reports of visible and felt effects of earthquakes has been considerably extended. The National Research Council, through its division of geology and geography, the

Jesuit Seismological Association, and other organizations, are cooperating efficiently in the eastern part of the country, and there has been a marked increase in cooperation with the San Francisco field station of this bureau in the collection of information for the Pacific coast region.

The various accomplishments of the Washington office are grouped according to the divisions to which they relate, as follows:

CHIEF CLERK

This office continued general supervision over all matters relating to personnel work; expenditures for office expenses, including purchase of supplies for the Washington office and to some extent for the field; care and custody in the library and archives of most of the original field survey records, as well as printed publications acquired; maintenance of mechanical equipment of the Washington office; and the custody and accounting for the receipts from sales of nautical charts, airway maps, nautical publications, old property, etc.

The number of persons in the service of the Coast and Geodetic Survey at the close of the fiscal year ended June 30, 1931, is shown in the following table:

Staffs	Commissioned	Civilian				Total
		Classified	Unclassified			
			Laborers	Seamen	Hands	
Washington office	15	234	4			253
Field service	149	70		524	263	1,006
Total	164	304	4	524	263	[1] 1,259

[1] These figures do not include the 40 civilian employees on duty at the Manila field station and the 102 members of the crews of the ships Fathomer and Marinduque who, while paid by the insular government, operate under the jurisdiction of officers of the Coast and Geodetic Survey. There is therefore a total of 1,401 actually serving with the Survey.

There were received in the library and archives 102 hydrographic and 69 topographic sheets, representing new surveys accomplished by the Survey. Other additions included 2,156 charts, 2,276 maps; 701 blue prints (mostly of surveys by engineers of the United States Army); 6,352 field, office, and observatory records; 310 photographs and negatives; 575 prints; 350 lantern slides; and 642 books.

Receipts from the sale of nautical charts, airway maps, and nautical publications prepared by the Survey totaled $72,394.95. Funds realized from the sale of old property and miscellaneous sources amounted to $1,704.56.

DIVISION OF ACCOUNTS

The regular annual appropriation for the Coast and Geodetic Survey for the fiscal year 1931 amounted to $2,916,524. This amount was supplemented by transfers from other departments, special appropriations, etc., to the extent of $243,400, making a grand total

of $3,159,924. The actual disbursements during the period of the fiscal year amounted to $3,154,967.43, distributed among the various appropriations as follows:

Vessel and tender, 1928–29	$33, 455. 75
Party expenses, 1929	56. 67
Repairs of vessels, 1929	52. 00
General expenses, 1929	31. 00
Repairs due to hurricane damage, 1929–30	2, 838. 55
Pay and allowances, commissioned officers, 1930	68, 611. 37
Salaries, 1930	175. 65
Party expenses, 1930	140, 447. 19
General expenses, 1930	16, 603. 48
Repairs of vessels, 1930	20, 671. 13
Pay, officers and men, vessels, 1930	153, 573. 01
Aircraft in commerce	3, 454. 70
Tender, 1930	32, 175. 00
War transfer to commerce	2, 337. 83
Vessel and tender, 1930–31	106, 500. 00
Pay and allowances, commissioned officers, 1931	543, 385. 63
Salaries, 1931	511, 357. 52
Party expenses, 1931	757, 720. 20
Repairs of vessels, 1931	74, 279. 34
General expenses, 1931	59, 122. 58
Pay, officers and men, vessels, 1931	575, 329. 29
Aircraft in commerce, 1931	34, 568. 47
War transfer to commerce	11, 279. 94
Repairs of vessels, 1931–32	6, 608. 63
Air navigation facilities, 1931	332. 50
Total	3, 154, 967. 43

DIVISION OF INSTRUMENTS

All instrumental equipment as well as the major part of the general property used by the field parties of the Survey is supplied by the division of instruments. This involves the purchase, inspection, and test of new instruments; the design and construction of new models in its own plant; research into the development of new materials and designs; and the maintenance of a large though simple accounting system to record the transfers of this valuable property. This division is also frequently called upon to assist other Federal agencies and private organizations in the preparation of specifications for and the inspection of new instrumental equipment of a wide variety of types.

Changing conditions and advancements in scientific knowledge require that the Survey in general and the division of instruments in particular be constantly alert to adopt any advantageous improvements and to make any changes in or devise new instruments that will render better service or reduce cost of construction or operation.

Some of the more important improvements brought out during the past year include the following:

Improvements in design and methods of constructing geodetic level rods, so that the length of members of pairs of rods do not differ by more than $\frac{1}{1000}$ of an inch. This accuracy alone has made possible a change in procedure resulting in an increase of approximately 15 per cent in leveling output.

A standard sextant was redesigned better to adapt it for horizontal angle measurement for hydrographic surveying. Larger stellite

weatherproof mirrors were installed. A large low-power telescope having a high light-gathering capacity was added, fitted with a focusing clamp to prevent the eyepiece being jarred out of adjustment when used in an open boat.

A seismograph recorder was designed and is now under construction which will provide for continuous operation at all times, in order to insure proper recording of the initial earthquake impulse. This recorder is operated on the ordinary electric-light circuit, but a battery is provided to insure continued operation should the regular current supply fail. In the event of an earthquake, the record will be made continuously for 30 minutes, long enough for most practical purposes.

Other instruments and improvements to existing types were brought forth tending to increase accuracy, stability, ease of operation, or to reduce costs.

Because of the great increase in field work in recent years, during which time there has been but one regular employee added to the division's force, every effort has been made to systematize the work, to insure an adequate supply of equipment, and to facilitate the handling of supplies, so that instruments can be shipped to field parties promptly.

DIVISION OF HYDROGRAPHY AND TOPOGRAPHY

All plans for field work and instruction for hydrographic and topographic surveys are made in this division. The section of vessels and equipment prepares plans for the construction of new vessels and equipment and for the repairs to existing plant and equipment. The coast pilot section makes field examinations and prepares manuscripts for new editions of the various Coast Pilots, publishes an annual supplement for 14 pilot volumes and prepares answers to numerous requests for information. The training section is now quartered on the ship *Oceanographer*, where newly appointed officers are given theoretical and practical instruction to fit them as ship's officers.

The construction of the new motor vessel *Hydrographer* was completed in March, since which the ship has been active in the survey of Georges Bank. The tender *Gilbert* was completed at Sturgeon Bay, Wis., in September, 1930, and after the trip to the Atlantic coast via the Great Lakes and the New York Barge Canal, has been engaged in surveys on the Florida coast and Georges Bank.

Plans and instructions were prepared for a continuance of work on Georges Bank, where four vessels are utilized. Improvements have been made in portable radio acoustic sound ranging stations.

Field examination was made and the manuscript partly prepared for a new edition of the Inside Route Pilot, New York to Key West. The manuscript for a new edition of Alaska Coast Pilot, Part II, was completed and sent to the printer. Work was started on a field examination for a new edition of Alaska Coast Pilot, Part I. Supplements were compiled and issued for 14 Coast Pilot volumes.

The office reduction of the phototopographic surveys of the coast of Florida and the Hudson River was completed and the office reduction begun of similar surveys in the vicinity of San Francisco.

DIVISION OF GEODESY

The following important pieces of work were completed or in progress at the end of the fiscal year:

Computation and adjustment of triangulation.—

1. Arcs of first-order triangulation as parts of the general eastern adjustment: Ninety-eighth meridian to Duluth, Minn.; forty-fourth parallel, ninety-eighth meridian to Fond du Lac, Wis.; forty-second parallel, ninety-eighth meridian to Chicago Heights, Ill.; thirty-ninth parallel, ninety-eighth meridian to oblique arc; thirty-seventh parallel, ninety-third meridian to oblique arc; thirty-fifth parallel, ninety-eighth meridian to Fort Smith, Ark.; ninety-eighth meridian to Mansfield, La.; ninety-third and ninety-fourth meridians, Royalton, Minn., to Beaumont, Tex.; Atlanta, Ga., to Shreveport, La.; Gulf coast, Mobile, Ala., to Beaumont, Tex.; Mississippi River, St. Louis, Mo., to New Orleans, La.; Lake survey, Duluth, Minn., to thirty-ninth parallel; Lake survey, Lakes Michigan and Superior to Detroit, Mich.; Lake survey and Canada, Chicago, Ill., to northeast Maine; Columbus arc, Sandusky to Portsmouth, Ohio; Kentucky arc, Portsmouth, Ohio, to oblique arc; Pittsburgh arc, Lake Erie to oblique arc; Buffalo, N. Y., to Trenton, N. J.; oblique arc, Maine to Alabama; Vermont—New York; and central New York.

2. Computation of 17 first-order base lines along the various arcs of triangulation included in the eastern adjustment, and one base line in California.

3. Southeast Alaska: Adjustment of several small pieces of triangulation to the main scheme work; adjustment of a traverse line from Icy Point to Lituya Bay.

4. Completion of the adjustment of the triangulation of Los Angeles County, Calif., to the North American datum of 1927.

5. Computation of a traverse line, about 30 miles long, established to connect one of the permanent marks of the Mississippi River Commission to the first-order triangulation net.

6. Completion of the reduction of the triangulation in Haro Straits, Wash., to the North American datum of 1927.

7. Adjustment of the triangulation along the Pacific coast to the North American datum of 1927.

Computation and adjustment of leveling.—

1. Computation of 131 miles of first-order leveling run during the fiscal year 1930, the computation of which was not completed at the end of that year.

2. Computation of 5,073 miles of the first-order leveling run during the fiscal year 1931.

3. Distribution of corrections through about 22,000 miles of old leveling to fit it to the results of the 1929 general adjustment.

4. Adjustment of about 250 miles of third-order leveling for the United States Engineer office at Louisville, Ky.

5. A preliminary adjustment of leveling in Oregon, to place elevations as nearly as possible on the 1929 general adjustment prior to the completion of the net in Oregon during the summer of 1931, after which final adjustment of the leveling in Oregon will be made.

6. Fitting new leveling to the 1929 General Adjustment.

Computation of astronomic and gravity work.—

1. Azimuths: 35 stations in the United States.

2. Longitudes: 59 stations in the United States; 1 in Hawaii.

3. Latitudes: 44 stations in the United States; 1 in Hawaii.

4. Laplace azimuths: Computation of true geodetic azimuths at 59 Laplace stations.

5. Isostatic reductions: Computation of the deflections of the vertical in the meridian at seven stations and in the prime vertical at two stations in the United States.

Investigations were carried on during the year in the following subjects: Interior of the earth, earth tides, variation of latitude, depth of isostatic compensation, and methods of reducing gravity observations.

The following publications were issued by the division of geodesy during the fiscal year:

Special Publication 5, Tables for a Polyconic Projection of Maps and Lengths of Terrestrial Arcs of Meridian and Parallels (fifth edition).
Special Publication 171, World Longitude Determinations by the United States Coast and Geodetic Survey in 1926.
Special Publication 172, First-Order Leveling in New Jersey.
Serial 502, First-Order Leveling.
Special Publication 173, Latitude Redeterminations.

DIVISION OF CHARTS

The major activities of the division of charts are the construction and maintenance of nautical charts and airway maps, including the review of field sheets, flight checks of airway map compilations, and hand corrections. Much time is given to the distribution to the public of charts, maps, and nautical publications which the bureau produces, and the issue of data from the Survey's files of original sheets for the use of its field parties or the public, as well as miscellaneous reproductions for other Federal agencies.

There has been no recession in any activity during the year. Some have increased. The total distribution of charts, maps, and nautical publications of the Survey reached over 364,000 items, the largest in its history. There has likewise been a large increase in the output of airway maps which, however, is only to be expected in view of the constant additions to the list of Commerce airway maps and the growth of air transportation. The first three of the sectional series of 92 maps were printed during the year, and a total of 28 strip maps have been issued to date.

In addition to the publication of the Weekly Notice to Mariners in conjunction with the Bureau of Lighthouses, the Survey issued 16 new nautical charts and 9 airway maps, shown in the following list of accomplishments during the year just closed:

Nautical charts:	
New	[1] 16
New editions	[1] 145
New prints	373
Reprints, no change	81
Airway maps:	
Sectional, new	3
Strip, new	6
Strip, reprints	6

The nautical chart program for the ensuing year includes 13 new charts, 3 reconstructions now in process, and several reconstructions of southeastern Alaska charts, in addition to the regular maintenance work required for existing charts. Airway map plans contemplate the completion of 3 strip and 10 sectional maps.

The following table shows the distribution of Coast and Geodetic Survey nautical publications and charts and airway maps; followed by an analysis of the distribution of nautical charts, and separate statements concerning the annual tide and current tables and the tidal-current charts good for any year.

[1] Includes 4 new and 4 new editions produced by the Manila field station.

Nautical charts, airway maps, and nautical publications distributed

Fiscal year	Nautical charts	Airway maps	Coast pilots	Inside-route pilots	Tide and current tables	Tidal-current charts
1920	311,699	----------	15,261	2,085	24,887	----------
1921	290,188	----------	8,728	2,656	24,212	----------
1922	215,509	----------	6,235	2,261	23,673	----------
1923	197,426	----------	6,610	1,787	[1] 26,788	----------
1924	221,543	----------	5,917	1,788	29,966	----------
1925	230,535	----------	5,733	1,727	29,720	----------
1926	232,286	----------	6,328	2,648	29,561	----------
1927	246,836	----------	7,859	1,994	31,570	----------
1928	241,880	----------	7,019	1,849	34,774	----------
1929	249,499	----------	6,288	1,756	37,378	[2] 1,453
1930	282,034	[3] 12,349	7,656	2,208	42,737	326
1931	286,168	18,138	6,480	1,909	50,366	1,784

[1] Current Tables issued as separate publications beginning 1923.
[2] First publication issued in 1929. Good for any year.
[3] Previously distributed by aeronautics branch.

Analysis of nautical chart distribution

Fiscal year	Sold	Per cent	Official distribution	Per cent	Condemned	Per cent	Total
1905	42,719	41.8	52,591	51.6	6,713	6.6	102,023
1910	52,068	43.6	58,307	48.8	9,019	7.6	119,394
1915	57,060	44.6	62,327	48.8	8,416	6.6	127,803
1920	124,845	40.1	173,929	55.8	12,925	4.1	311,699
1925	102,011	44.2	111,552	48.4	16,972	7.4	230,535
1926	132,605	57.1	85,171	36.6	14,510	6.3	232,286
1927	119,593	48.5	111,383	45.1	15,860	6.4	246,836
1928	122,242	50.5	106,654	44.1	12,984	5.4	241,880
1929	135,170	54.2	103,391	41.4	10,938	4.4	249,499
1930	153,995	54.6	110,151	39.1	17,888	6.3	282,034
1931	133,453	46.6	132,073	46.2	20,642	7.2	286,168

Distribution of tide tables and current tables [1]

Fiscal year	Annual tide tables			Annual current tables	
	United States and Foreign ports	Atlantic coast, North America	Pacific coast, North America, eastern Asia, and island groups	Atlantic coast, North America	Pacific coast, North America, and Philippine Islands
1920	3,469	5,357	16,061	----------	----------
1921	3,577	5,678	14,957	----------	----------
1922	3,067	5,704	14,902	----------	----------
1923	2,479	5,440	15,054	2,029	1,786
1924	2,509	7,097	15,234	3,124	2,002
1925	2,218	6,727	15,849	2,452	2,474
1926	2,730	6,707	15,347	3,014	1,763
1927	2,692	6,934	15,911	3,722	2,311
1928	2,377	7,281	17,009	3,614	2,501
1929	3,257	7,276	16,896	3,492	4,040
1930	2,605	8,462	16,889	4,054	3,099
1931	2,755	8,135	16,152	3,984	2,824

[1] The distribution of the combined tide and current tables (pocket-size edition) issued to date for certain waterways is not included herein but shown in the table following.

Distribution of tidal-current charts and annual pocket-edition tide and current tables

Fiscal year	Annual tide and current tables				Tidal-current charts		
	New York Harbor	Massachusetts Bay	San Francisco Bay	Puget Sound	New York Harbor	Boston Harbor	San Francisco Bay
1928	1,992						
1929	956	1,461			1,453		
1930	1,134	1,470	5,024		326		
1931	9,268	1,705	4,725	758	416	555	813

DIVISION OF TIDES AND CURRENTS

The growing public demand for tide and current information is responsible for the ever-increasing amount of work in the division of tides and currents. Not only must the data secured from the various comprehensive tide and current surveys made each year since 1922 be reduced, correlated, and published, but there must also be prepared the tidal bench mark publications and the several annual tide and current tables.

The manuscript of a special publication on Tides and Currents in Long Island and Block Island Sounds was completed and work is now in progress on two additional publications of this series—Hudson River and Narragansett Bay. The publications of this series and the year of issue are listed below:

Tides and currents in harbors

New York Harbor, 1925.
San Francisco Bay, 1925.
Delaware Bay, and River, 1926.
Southeast Alaska, 1927.
Boston Harbor, 1928.
Portsmouth Harbor, 1929.
Chesapeake Bay, 1930.

The list of annual tide tables was augmented by the addition of a tide and current table for Puget Sound and Vicinity for the calendar year 1931. Information on currents was included in all of the pocket-size tables for 1931 and their names changed from "tide" to "tide and current" tables. They are therefore now issued for New York Harbor, Massachusetts Bay, San Francisco Bay, and Puget Sound.

Tables showing the issue of the tide and current tables for the 12-year period 1920–1931, shown on preceding page, is indicative of the demand for these publications.

The Tide Tables, United States and Foreign Ports, for 1931 include daily predictions for 92 reference stations and tidal differences and constants for 3,830 subordinate stations. Two new reference stations, Cristobal, Canal Zone, and Ketchikan, Alaska, are included, and Immingham, England, substituted for Hull, England, in the 1932 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, 20 stations; Canadian Hydrographic Office, 4 stations; Deutsche Seewarte, 6 stations; Service Hydrographique, France, 4 stations; and Geodetic Branch, Survey of India, 5 stations.

During the fiscal year tidal current charts were printed for San Francisco Bay and Boston Harbor, these two publications being the second and third of the series to be published for the more important waterways. They are printed in colors, show for each tidal hour the direction and velocity of the current throughout the area covered, and may be used for any year. The tidal current series have proved valuable not only to the mariner but the engineer and scientist confronted with problems involving the circulation of surface waters.

Work has progressed during the fiscal year on two tidal bench mark publications, one for the State of Washington and the other for the States of Maine and New Hampshire. The following list gives the publications of this series already printed and the year issued.

Tidal bench mark publications

New York, 1922.
District of Columbia, 1925.
Rhode Island, 1926.
Connecticut, 1927.
California 1928.
New Jersey, 1929.
Massachusetts, 1929.
Oregon, 1930.

DIVISION OF TERRESTRIAL MAGNETISM AND SEISMOLOGY

Terrestrial magnetism.—Steady progress has been made in the preparation for publication of observatory results. More than half of the work necessary to prepare the 1925–26 series for publication was accomplished during the year. The amount of office work has been curtailed considerably by the method of direct scaling of the final values from the records, which is now made at all the observatories in accordance with the plan adopted some years ago.

The results of field observations in 1930 are now ready for publication and considerable progress has been made on the publications Magnetic Declination in the United States for 1930, and Magnetic Declination in Alaska in 1930.

The publication series giving information regarding the magnetic declination for individual or groups of States will be added to shortly by a publication covering the States from South Carolina to Louisiana. The edition for California and Nevada is being revised.

A study has been given to improvements of instruments and methods, and especially to the routine operation of observatories with a view to producing uniformly good records with a minimum effort. There has been gratifying cooperation in the study of terrestrial magnetism with a number of other organizations, notably the Carnegie Institution of Washington, the Bureau of Standards, the Naval Research Laboratory, and a number of transmission organizations including radio broadcasting companies. Members of the division have participated in the activities of various scientific organizations, as officers and in the presentations of papers and attendance at international meetings relating to these subjects.

Seismology.—The publication Earthquakes of the United States, for a given year are being brought up to date with the issue of the publication for 1929. The report for 1930 is also nearly completed.

Forty-six determinations of positions of earthquakes, and the transmission of this information west to Manila and east to Europe, were made during the year. Cooperation and advice have been

given to universities and other organizations contemplating or actually installing seismographs. Interpretations of records furnished by such organizations have been made.

Through funds furnished by the Coast and Geodetic Survey, the Bureau of Standards has started the development of a strong motion seismograph to be used in recording strong earthquake motions. A suitable automatic recorder is being developed by the division of instruments of this bureau. Other useful instruments are being developed by other organizations.

Very truly yours,

R. S. PATTON, *Director.*

BUREAU OF NAVIGATION

DEPARTMENT OF COMMERCE,
BUREAU OF NAVIGATION,
Washington, July 1, 1931.

The honorable the SECRETARY OF COMMERCE.

DEAR MR. SECRETARY: In response to your request I submit the following report on the work of the bureau during the past fiscal year:

AMERICAN SHIPPING ON JUNE 30, 1931

On June 30, 1931, the merchant marine of the United States, including all kinds of documented craft, comprised 25,471 vessels of 15,908,256 gross tons, of which 1,998 seagoing vessels of 9,922,771 gross tons were of 1,000 tons or over, compared with 2,105 vessels of 10,233,125 gross tons on June 30, 1930. Following is an analysis of the ownership of seagoing tonnage compared with one year ago:

Ownership and date	Steel		Wood		Total	
Private ownership (500 gross tons and over):	*Number*	*Gross tons*	*Number*	*Gross tons*	*Number*	*Gross tons*
July 1, 1930	1,449	7,207,405	482	610,961	1,931	7,818,366
July 1, 1931	1,468	7,395,551	400	497,753	1,868	7,893,304
U. S. Shipping Board (1,000 gross tons and over):						
July 1, 1930	478	2,663,879	----------	----------	478	2,663,879
July 1, 1931	397	2,239,153	----------	----------	397	2,239,153
Total, 1930	1,927	9,871,284	482	610,961	2,409	10,482,245
Total, 1931	1,865	9,634,704	400	497,753	2,265	10,132,457

Of these totals 1,001 vessels of 5,488,939 gross tons were engaged in the foreign trade and 1,264 vessels of 4,643,518 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 gradual decline, until June 1, 1931, it amounted to only 5,623,300 gross tons, a falling off of 5,076,296 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 2,092,472 gross tons. During the same 10 years the total seagoing tonnage has decreased 2,983,824 gross tons.

During the year, 1,302 vessels of 386,906 gross tons were built and documented, and on July 1, 1931, there were building or under contract to build in our shipyards for private shipowners 105 vessels of 358,904 gross tons. The corresponding figures for 1930 were 1,020

vessels of 254,296 gross tons built and 291 vessels of 486,602 gross tons under contract to build.

The new tonnage includes 7 steel passenger steamers of 63,155 gross tons, 3 steel steam ferries of 8,118 gross tons, 6 steel steam tankers of 49,390 gross tons, 1 steel passenger motor ship of 9,180 gross tons, 1 steel cargo motor ship of 1,112 gross tons, and 5 steel motor-ship tankers of 44,407 gross tons, aggregating 178,138 gross tons. These figures include only steel steam and motor vessels of 1,000 gross tons and over, and of this total 161,700 gross tons are seagoing.

The total horsepower of these new vessels is 116,120 compared with 77,940 for the same class of vessels built during the year ended June 30, 1930.

On June 30, 1931, the laid-up seagoing tonnage of the United States aggregated 389 vessels of 1,253,756 gross tons, as against 541 vessels of 2,096,179 gross tons on June 30, 1930.

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 1931, a publication prepared by this office.

With the volume of the world's merchant shipbuilding smaller than at any time in the past four years, as reported by Lloyd's for all principal maritime nations (except Russia, from which no figures are available), American shipbuilding has risen to a new high record for postwar construction and, with the exception of the war period, it is the greatest in its history. Approximately two-thirds of the world's decline is accounted for by the falling off of work in the shipyards in Great Britain and Ireland, and Germany, Holland, and Japan also report a considerable decline. France alone of all foreign countries shows an increase in shipbuilding.

NAVIGATION LAWS

Under section 4 of the organic act of this bureau, July 5, 1884, directing the Commissioner of Navigation to investigate the operations of the laws relating to navigation and annually report to you such particulars as may admit of improvement or require amendment, the following is suggested:

LOAD LINES

The United States Senate through Resolution 345 requested you to make a comprehensive study of load-line legislation in the coastwise and intercoastal trade and on the Great Lakes, and present to the Congress a tentative draft of a bill to effectuate your recommendations.

You prepared such a bill which was before Congress during the last session but was not acted upon.

A load-line law for the coastwise trade seems desirable for the protection of life and property. It also relieves the careful, conservative operator from the unfair competition of the small minority of owners who may be tempted to give more weight to the possible profit of the voyage than to the safety of the crew.

Vessels in these trades as a rule have not been marked with load lines. Pending action by the Congress your technical committee is making an exhaustive study of the requirements of vessels in the coastwise and intercoastal trades in order that there may be pre-

pared recommendations for the determinations of load lines for vessels in those trades which will be in accord with safe established practice.

For the Great Lakes a special committee has been appointed to consider and make a careful study of various types and character of vessels trading in those waters.

This preliminary study will enable the department, should the bill become law, to advise owners in ample time regarding the regulations for the establishment of such load lines. Compliance with the law when it becomes effective may then be accomplished in an orderly manner and without causing owners unnecessary expense.

The bill before Congress is practically identical with our present load-line law except as to the vessels which it covers. The department's committees are endeavoring to so adjust the regulations under the proposed law that the maximum safety to passengers and crew may be secured without imposition of unnecessary hardships on specialized trades.

COASTING TRADE

The transportation of passengers in our domestic trade on foreign vessels is of growing importance. The phraseology of section 2 of the act of February 17, 1898, covering this subject, permits the use of foreign vessels in our domestic trade provided that they transport passengers on sight-seeing tours from one American port to another and return to the original port of departure by way of foreign ports. It also permits foreign vessels to take on passengers, for instance, at New York, transport them on a voyage on the high seas, and return to New York. Because of the differences of laws and conditions governing foreign vessels on the high seas, this trade is increasing. This invasion of our domestic trade apparently can be remedied only by act of Congress.

INSPECTION OF MOTOR SHIPS

The bureau again suggests the desirability of amending the steamboat inspection laws so as to cover fully the inspection of the increasing number of large vessels propelled by internal-combustion engines. The steamboat inspection laws originally contained in Title LII of the Revised Statutes covered only sail and steam vessels. Later section 4426, Revised Statutes, applied to a limited extent to internal-combustion engine propelled vessels.

It is very doubtful under existing law whether the Government can compel the full inspection and equipment with life-saving devices of motor vessels regardless of size.

There are in the United States 12,124 documented motor vessels of 981,858 tons. Of this number, 143 of these vessels are 1,000 tons or over, the total tonnage of these large vessels aggregating 604,263 tons. In addition to the above there are over 250,000 American-owned undocumented motor vessels.

Because of their size and the waters which they navigate it doubtless would be an unnecessary hardship to extend all of the inspection laws to these small vessels. It appears, however, that seagoing vessels of 100 gross tons and over should be subject to these laws in the interest of safety of life and property.

INTERNATIONAL CONVENTION ON SAFETY OF LIFE AT SEA

This convention was signed at London on May 31, 1929, by 18 of the principal maritime nations. In the fall of that year it was presented to the United States Senate for ratification, but was not reported out of the Senate Committee on Foreign Relations during the last Congress.

It is important to the United States that this convention be ratified as early as possible. The number of citizens of the United States in international travel whose safety is affected by the terms of this convention is perhaps as large as that of any other nation, and the interest of the United States in the convention accordingly is correspondingly great. It is hoped that this convention will be reported out of the committee and ratified during the coming session.

INTERNATIONAL CONVENTION ON LOAD LINES

One of the outstanding events of the year, marking perhaps one of the most important epochs in the history of the merchant services of the world, was the signing of the International Load Line Convention in London in July, 1930. This convention was a fitting conclusion to the labors of the International Convention on Safety of Life at Sea in the previous year.

The terms of the convention which were made public the early part of September, 1930, have given general satisfaction. It is the consensus of opinion that these new rules will raise the standard of safety of the merchant shipping throughout the world. Emphasis is laid in the convention for the safety of the crew in the performance of their duties; also for securing and maintaining the effective closing of openings in the weather decks and in the sides of ships. The oceans of the world have been divided into weather zones regulating the loading of ships operating in those zones.

This convention was ratified by the United States Senate on February 27, 1931.

LOAD LINE ACT OF MARCH 2, 1929

The law requiring load lines on American vessels became effective on September 2, 1930. For the first time in load-line history it is now possible for American ships to enter foreign ports on a legal parity with other ships rather than by virtue of international courtesy. The rules and regulations adopted by the Secretary of Commerce under the act are based to a considerable extent on a most exhaustive study of ship construction and loading by a technical committee appointed for the purpose in 1928 by the Secretary of Commerce. In these regulations due consideration was given to and differentials made for the various types and character of vessels and the trades in which they are engaged.

These regulations also are in close accord with the conclusions reached by the world's leading load-line experts at an international conference held in 1930 which was ratified by the United States Senate in 1931.

There are approximately 1,500 vessels subject to this law. Up to July 1, 1931, 1,189 of these vessels have applied for load lines and 479 load-line certificates have been issued.

In the enforcement of the law, 122 vessels have been reported for violation of the law or regulations. With the exception of 11 cases, these violations have been due to inability to have the load line marked promptly, or other conditions which warranted the department in remitting the penalty. On 11 occasions, however, the conditions required prosecution.

The work of placing the load lines is proceeding as rapidly as the personnel of the assigning authorities and the movement of ships will permit.

In considering action to be taken in connection with the mitigation of penalties the department takes into consideration that this is a new law, the time it takes for the agencies of the Government to assign these load lines, and the steps the owners have taken to comply with the requirements of the statute.

At the same time the safety of the ship and those on board is given first consideration, and whether these vessels have load lines assigned under our regulations or those of the British Board of Trade, such load lines must not be submerged.

The Department of State is in communication with the maritime nations of the world with a view to securing reciprocal acceptances of load-line certificates as contemplated by section 5 of our act.

It is fortunate that the provisions of the act of 1929 made it possible for the United States so promptly to put into effect the principal provisions of the international convention signed in London in July, 1930. Seldom have technical experts reached so complete an agreement as to the practical good sense of the principles adopted as was the case in the London convention of 1930.

ADMEASUREMENT OF VESSELS

A committee of the League of Nations has been conducting an inquiry since 1927 with a view to securing equality in practice in applying the existing systems of tonnage admeasurement to ships of all flags.

While the United States is not a member of the League of Nations, practical suggestions made by the committee have been examined in consultation with a representative of the United States who has attended the meeting as an observer.

It is understood that further international consideration will be given to the subject by the League of Nations during the coming year. The importance of international uniformity in the admeasurement of vessels is obvious.

ADMINISTRATION OF THE NAVIGATION LAWS

There has been presented to you the present unbusinesslike and inefficient organization of the field service of this bureau in the enforcement of the navigation laws.

At the beginning of our Government the administration of these laws was intrusted to collectors of customs acting under instructions of the Secretary of the Treasury, as those officers, located at every port of entry, were easily accessible to shipowners and masters.

On the creation of the Department of Commerce this administration, which directly affects the movement of commerce, was transferred to this department, but the employees and machinery neces-

sary 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.

It is becoming more and more evident that action in this matter must be taken in the near future in the interests of our merchant marine and merchant seamen.

The solution, of course, is the transfer to the Department of Commerce of the personnel of the marine divisions of the customhouses which are engaged solely on navigation work and acting under the direct instructions of the Bureau of Navigation. The disadvantages as to our merchant marine of the present system are being emphasized as new laws are enacted placing in the Department of Commerce added duties and responsibilities.

NAVIGATION PATROL SERVICE

In accordance with the bureau's recommendation of last year Congress provided for an addition to our inspection fleet which permitted us to assign a vessel to the Great Lakes. This is an important addition to our facilities, as on the waters of the Great Lakes there are 987 documented vessels of over 2,600,000 gross tons, and more than 32,000 smaller vessels carrying during the season millions of our people in commerce and for pleasure.

The action of Congress also provided for the placing on Chesapeake and Delaware Bays a more suitable vessel which enables us to conduct with much greater efficiency the inspection work of those busy waters.

After nearly 20 years' experience in the supervision of small motor vessels, this bureau is satisfied that Congress has made ample provision for the safety of those on board, provided that there is a compliance with the law. In this work the bureau has met with the general cooperation of motor-boat owners and organizations, yacht clubs, and motor-boat publications. The work of the boats, together with this cooperation, has resulted in a very general compliance with the requirements.

This, together with the improved construction of these small vessels and their engines, has resulted in a very material reduction in the loss of life in such navigation and has given much impetus to the sport of motor boating.

ENFORCEMENT OF NAVIGATION LAWS

The work of general enforcement of the navigation laws throughout the year has proceeded along regularly established lines. The enforcement of the rules and regulations governing the movement of vessels in the St. Marys River and the patrol of the course during regattas and marine parades have been carried out by the Coast Guard in its usual efficient manner. The same service again has been active in inspecting small vessels for life-saving equipment and has brought to the attention of the bureau many violations of the navigation laws.

During the year there were reported 7,187 violations of the various laws we administer and on which the department acted in the mitigation or remission of penalties incurred.

The following table shows the enforcement of such laws by customs districts and laws violated:

Headquarters port	Total	Steamboat laws	Motor-boat laws	Surrendered license	Seamen's act	Anchorage and St. Marys River rules	Passenger act	Enrollment and license	Entry and clearance	Name on vessel	Change of master	Unlading	Load line act	Numbering act	Miscellaneous
Baltimore	584	38	399	14	----	----	----	1	----	13	----	----	5	105	9
Boston	509	29	257	40	----	----	2	19	9	15	3	5	3	86	41
Bridgeport	163	1	87	39	1	----	----	6	2	3	5	----	----	18	1
Buffalo	83	5	65	2	----	----	----	----	2	4	----	----	----	4	1
Charleston	49	1	10	33	----	----	----	----	----	----	----	----	----	1	4
Chicago	37	4	11	8	----	1	----	----	----	1	1	----	----	10	1
Cleveland	167	3	120	12	3	----	----	----	9	4	----	----	----	16	----
Detroit	185	3	71	45	1	----	----	7	5	5	----	----	----	31	17
Duluth	27	----	21	4	----	----	----	----	----	----	----	----	----	1	1
Galveston	39	3	13	10	----	----	----	2	4	----	1	1	1	3	1
Honolulu	15	----	1	3	----	----	----	----	1	----	----	----	----	1	9
Indianapolis	4	----	4	----	----	----	----	----	----	----	----	----	----	----	----
Juneau	47	----	1	27	----	----	----	1	4	----	1	----	----	11	2
Los Angeles	400	16	74	51	----	----	----	9	14	----	1	2	91	42	100
Louisville	9	----	7	2	----	----	----	----	----	----	----	----	----	----	----
Memphis	48	1	8	13	----	----	----	4	----	----	----	----	----	22	----
Milwaukee	9	----	4	4	----	----	----	----	----	----	----	----	----	1	----
Mobile	95	5	33	35	----	----	----	1	----	10	----	----	----	10	1
New Orleans	187	4	69	13	----	----	----	6	1	30	4	----	----	60	----
New York	828	14	362	180	----	----	----	140	8	39	19	----	----	49	17
Norfolk	228	10	109	29	1	----	----	9	8	13	----	----	3	40	6
Ogdensburg	28	----	13	11	----	----	----	----	4	----	----	----	----	----	----
Philadelphia	511	3	256	75	----	----	----	4	----	23	7	----	----	139	4
Pittsburgh	9	4	----	5	----	----	----	----	----	----	----	----	----	----	----
Port Arthur	26	2	5	17	----	----	----	----	----	----	----	----	----	2	----
Portland, Me	315	3	155	20	----	----	----	2	----	10	----	1	1	118	5
Portland, Oreg	129	4	61	19	----	----	----	----	5	1	----	----	4	33	2
Providence	47	----	35	5	----	----	----	2	----	1	----	----	----	4	----
Rochester	86	1	79	----	----	----	----	----	----	4	----	----	----	2	----
St. Albans	170	----	----	----	----	----	----	----	170	----	----	----	----	----	----
St. Louis	6	----	----	4	----	----	----	----	----	----	----	----	----	2	----
St. Paul	2	----	----	----	----	----	----	----	----	----	----	----	----	----	2
San Antonio	72	----	26	4	----	----	----	----	----	----	----	----	----	42	----
San Diego	22	----	4	4	----	----	----	2	----	----	----	----	----	10	2
San Francisco	232	10	72	40	----	----	3	5	4	5	1	----	20	52	20
San Juan	23	----	5	7	----	----	----	----	2	----	----	----	----	3	6
Savannah	91	----	66	4	----	----	----	4	1	8	----	----	----	8	----
Seattle	581	13	226	70	2	----	2	69	8	15	4	11	17	119	25
Tampa	928	4	516	75	----	----	----	12	44	39	1	----	11	224	2
Wilmington, N. C	196	9	119	29	----	----	----	4	----	9	2	----	----	20	4
Total	7,187	190	3,364	953	8	1	7	309	305	252	50	20	156	1,289	283

The following table shows the work done by the various branches of the Federal service engaged in the enforcement of the navigation laws in comparison with previous years:

Headquarters port	Total	Kilkenny	Tarragon	Dixie	Siwash	Psyche	Coast Guard	Local inspectors	Customs	Navigation inspectors
Baltimore	584	537					3	25	19	
Boston	509				252		57	25	175	
Bridgeport	163				84		5	4	70	
Buffalo	83					12	18	3	16	34
Charleston	49		2				14		33	
Chicago	37						9	4	8	16
Cleveland	167					50	27	6	33	51
Detroit	185					20	79	3	83	
Duluth	27						6		4	17
Galveston	39						8	3	28	
Honolulu	15								15	
Indianapolis	4									4
Juneau	47						3		44	
Los Angeles	400						49	16	254	81
Louisville	9						5		2	2
Memphis	48								38	10
Milwaukee	9						2	2	5	
Mobile	95		46				2	5	42	
New Orleans	187		135				26	6	20	
New York	828				194	138	239	11	246	
Norfolk	228	130				10	39	4	45	
Ogdensburg	28								28	
Philadelphia	511	209					130	2	170	
Pittsburgh	9								9	
Port Arthur	26							1	25	
Portland, Me	315				166		8	5	132	4
Portland, Oreg	129						2	3	57	67
Providence	47				10		3		6	28
Rochester	86					24	45	1		16
St. Albans	170								170	
St. Louis	6								6	
St. Paul	2								2	
San Antonio	72						9		60	3
San Diego	22						7		15	
San Francisco	232						90	10	132	
San Juan	23								23	
Savannah	91		71				11		9	
Seattle	581						241		327	13
Tampa	928	122	225	50			217	2	312	
Wilmington, N. C	196	88				38	41		29	
Total	7,187	1,086	298	231	706	292	1,395	141	2,692	346

Of the 7,187 violations reported, 2,613 were discovered by the five patrol boats of the navigation service. These vessels operate along the Atlantic and Gulf coasts. The record of the work of these vessels is better shown by the fact that during the year they made 26,972 inspections. The number of violations found as compared with the number of inspections is a fair index of the extent to which the safety laws on small vessels are being complied with.

On July 1, 1931, there was placed in operation an additional vessel enabling us to institute an inspection service on the Great Lakes.

Following is a comparative statement of cases of violations of the navigation laws, 1917–1931:

Port	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931
Baltimore	461	265	500	663	699	482	480	419	161	300	361	551	517	746	584
Boston	427	194	243	626	607	898	711	566	767	800	833	513	534	441	509
Bridgeport	89	32	95	97	200	50	287	131	206	131	310	231	199	182	163
Buffalo	87	111	168	143	188	62	116	262	90	24	34	257	103	43	83
Charleston	50	28	109	40	44	68	192	136	105	82	110	82	57	68	49
Chicago	283	144	88	119	171	97	179	165	139	76	97	30	68	49	37
Cleveland	161	177	499	1,096	252	160	154	303	187	97	84	168	144	172	167
Des Moines	116	56	27	40	141	32	62	48	11			3			
Detroit	163	146	142	122	168	67	184	311	80	83	184	182	202	234	185
Duluth	138	132	282	241	73	68	245	79	44	42	38	33	46	30	27
Eagle Pass	1	1													
Galveston	105	54	21	24	41	8	10	167	78	57	26	31	14	32	39
Great Falls								3					1		
Honolulu	18	11	10	3	95	35	22	16	45	10	12	18	14	32	15
Indianapolis	54	85	32	34	29	37	3	2	4		7	4	8	12	4
Juneau	40	44	43	39	60	36	77	130	106	78	51	45	55	58	47
Laredo	10														
Los Angeles	137	109	192	125	183	185	178	131	127	171	261	281	405	336	400
Louisville	128	50	49	64	35	57	29	26	28	54	35	18	44	8	9
Memphis	84	18	67	83	66	86	62	162	150	154	120	49	81	35	48
Milwaukee	82	18	81	133	33	14	79	17	5	7	104	1	25	26	9
Mobile	109	52	98	122	301	203	334	234	191	96	263	42	186	76	95
New Orleans	315	221	501	487	779	294	467	790	371	411	186	285	226	217	187
New York	1,292	583	626	1,349	849	2,698	1,475	663	1,625	2,454	1,185	1,170	1,233	951	828
Nogales		22		8	21	13		7	12	10	14	3	9	2	
Norfolk	430	181	814	618	846	680	682	412	375	842	434	345	354	448	228
Ogdensburg	74	201	54	18	8	85	85	18	112	58	142	50	87	36	28
Omaha					1							2	2		
Pembina		3											1	1	
Philadelphia	406	166	532	600	684	778	624	360	854	549	303	493	466	568	511
Pittsburgh	4	6	9	28	16	22	14	41	35	16	53	39	43	23	9
Port Arthur	93	117	203	256	112	21	17	216	84	52	15	61	29	24	26
Portland, Me	145	51	53	55	320	346	440	295	393	684	159	645	337	264	315
Portland, Oreg	130	239	120	182	107	83	101	171	291	237	84	100	125	86	129
Providence	94	68	65	137	175	181	98	94	144	169	217	104	113	103	47
Rochester	44	102	14	24	55	10	61	57	53	18	24	130	34	75	86
St. Albans	68	29	1	1	3	96	2		4	4	22			41	170
St. Louis	348	173	291	396	182	173	179	127	89	100	64	57	46	9	6
St. Paul			4							1					2
San Antonio		2	2	7	9	10	25	23	28	15	8	9	34	16	72
San Diego				1	22	34	32								22
San Francisco	196	151	223	765	466	213	291	288	284	281	238	277	227	327	232
San Juan	12	14	8	14	10	14	19	18	26	25	22	23	25	10	23
Savannah	48	41	77	68	149	165	163	126	126	67	47	60	95	105	91
Seattle	318	338	266	320	310	272	1,223	294	564	755	328	360	290	336	581
Tampa	547	295	1,303	1,247	1,770	2,300	1,649	1,386	1,398	1,690	1,519	1,609	1,075	977	928
Wilmington, N.C.	262	19	261	302	426	263	200	173	152	78	312	282	333	218	196
Total	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	7,417	7,187

PREVENTING OVERCROWDING OF PASSENGER VESSELS

The service of preventing the overcrowding of passenger vessels at 22 of the leading ports of the country proceeded effectively during the year. This has resulted in the report to the bureau of few violations of the law. Our inspectors are placed at the gangplank with automatic counters and to a very considerable extent the master relies on those counts to prevent the overcrowding of his vessel.

The following table shows the counts made by the navigation and customs services by ports:

Port	Navigation		Customs		Total	
	Counts	Passengers	Counts	Passengers	Counts	Passengers
Baltimore	1,916	598,927			1,916	598,927
Boston	29	27,371	338	200,142	367	228,513
Bridgeport			5	6,964	5	6,964
Buffalo			407	136,328	407	136,328
Chicago	1,554	290,153	34	25,435	1,588	315,588
Cleveland	417	321,828	444	333,746	861	655,574
Detroit	879	861,518	3	1,156	882	862,674
Duluth		14,780				14,780
Galveston			53	4,485	53	4,485
Indianapolis	9	3,294	2	1,198	11	4,492
Louisville	113	84,236			113	84,236
Memphis	18	7,132			18	7,132
Mobile	66	5,502			66	5,502
New York			119	1,861,872	119	1,861,872
Norfolk	367	57,306	3	1,049	370	58,355
Philadelphia			116	85,449	116	85,449
Portland, Me	249	40,273	1	245	250	40,518
Portland, Oreg			3	271	3	271
Providence	6	1,127			6	1,127
Rochester			24	4,483	24	4,483
San Francisco	343	11,268	742	19,635	1,085	30,903
Seattle	245	32,624	1,912	41,755	2,157	74,379
Total, 1931	6,211	2,357,339	4,206	2,725,213	10,417	5,082,552
Total, 1930	6,491	2,805,861	2,239	2,803,721	8,733	5,609,582

On 411 occasions during the year it was necessary for the inspectors to stop passengers from going on board, the limit of safety having been reached. This involved 93,993 passengers.

The bureau has found in the enforcement of the overcrowding law as well as that of others of the navigation laws that there is a practically universal effort on the part of the masters of vessels to comply with the safety requirements in spite of the temptation to produce additional revenue through the carrying of excess passengers.

The following table shows in detail by ports these shut-offs:

	July, 1930		August, 1930		May, 1931		June, 1931		Total	
	Counts	Passengers	Counts	Passengers	Counts	Passengers	Counts	Passengers	Count	Passengers
Baltimore	4	3,300	3	3,800			3	5,900	10	13,000
Boston	4	5,010	2	3,300	4	1,500			10	9,810
Chicago	30	5,004	4	1,152			6	1,508	40	7,664
Cleveland	4	4,800	7	8,400			1	150	12	13,350
Detroit	3	9,523					8	25,062	11	34,585
New York							31	4,425	31	4,425
Norfolk	7	2,187	7	3,012					14	5,199
Seattle	26	673	257	5,287					283	5,960
Total, 1931	78	30,497	280	24,951	4	1,500	49	37,045	411	93,993
Total, 1930	79	85,723	158	31,704	21	8,896	58	36,862	316	163,185

SHIPPING COMMISSIONERS

During the year 589,901 seamen were shipped, reshipped, and discharged as compared with 650,673 the year before. The average cost to the Government per man was 26 cents.

Collectors of customs acting at ports where shipping commissioners' offices have not been established shipped and discharged during the

year 39,772 officers and men as compared with 44,197 during the previous year.

Of the 305,629 men shipped before shipping commissioners, 159,481 were native Americans and 53,046 were naturalized Americans; 212,527 in all, or 69.5 per cent.

In addition to these numbers, there are shipped in foreign ports for the round voyage many seamen who do not appear before our shipping commissioners. These numbers are not included in the above figures.

The following table 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
1920	628,980	$89,949	$0.13	1926	534,493	$123,183	$0.23
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
1924	555,633	94,476	.17	1930	650,673	147,873	.23
1925	552,124	123,726	.22	1931	589,901	152,003	.26

During this year there was opened a new shipping commissioner's office at Portland, Oreg., the work of that port having grown to such an extent that it was necessary to have specially qualified officers in charge.

The work of the shipping commissioners extends so directly to the welfare of the seamen, maintenance of discipline on shipboard, and is is so intimately connected with the success of our merchant marine that as the work of the various ports increases it will be necessary to open from time to time new shipping commissioner's offices.

During the year there has been turned over to shipping commissioners $46,921.50 in unclaimed, deserters', and deceased seamen's wages. The commissioners are under heavy bond and are responsible for this money.

PASSENGER ACT OF 1882

The condition of the accommodations extended to steerage passengers in recent years is a very material improvement over that 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 1926 on steam vessels inspected for this purpose and the number of voyages made by such vessels:

Year	Voyages	Steerage passengers	Year	Voyages	Steerage passengers
1926	1,334	215,639	1929	1,422	327,018
1927	1,367	275,175	1930	1,347	326,767
1928	1,384	301,223	1931	1,310	255,158

NAVIGATION RECEIPTS

The Bureau of Navigation has collected from all sources during the year $2,323,865.32. This is a slight increase over the collections for the previous year.

June 30—	Tonnage duties	Navigation fees	Navigation fines	Total
1931	$1,777,612.54	$205,534.43	$340,718.35	$2,323,865.32
1930	2,021,295.94	236,781.02	62,593.23	2,320,670.19
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 Seagoing Vessels (annual), and American Documented Seagoing Merchant 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 governing the navigation of the St. Marys River, the establishment of load lines, the admeasurement of vessels, the navigation and equipping of small motor boats, the recording of mortgages and bills of sale, and regulations governing regattas and marine parades.

Very truly yours,

A. J. TYRER,
Commissioner of Navigation.

STEAMBOAT INSPECTION SERVICE

DEPARTMENT OF COMMERCE,
STEAMBOAT INSPECTION SERVICE,
Washington, July 1, 1931.

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, 1931.

PERSONNEL

The following positions were embraced in the service at the end of June, 1931:

Central office:	
Supervising Inspector General	1
Deputy Supervising Inspector General	1
Administrative assistant to the Supervising Inspector General	1
Traveling inspectors	6
Clerks	12
Messenger	1
Total, central office	22
Field:	
Supervising inspectors	11
Local inspectors of hulls	47
Local inspectors of boilers	47
Assistant inspectors of hulls	97
Assistant inspectors of boilers	96
Clerks	109
Total, field	407
Grand total	429

IMPROVED SHIP CONSTRUCTION

HULLS AND EQUIPMENT

In previous annual reports, it has been pointed out how desirable it would be to have the plans of hull construction passed on in the central office and instructions given to the inspectors in the field as to the details of this construction. The convention that was adopted at the Conference on Safety of Life at Sea in London in 1929 embodies a high standard of construction. That convention has not yet been ratified by the Senate, but if it is ratified, details of hull construction must receive increased attention on the part of the central office. Especially is this true concerning the bulkheading of ships. If the London convention is not ratified by the United States, it will become necessary for the Board of Supervising Inspectors to formulate

regulations that will obtain the highest standard of construction in the subdivision of ships. In either event, it will be necessary to have stationed in the central office men technically qualified to work out the regulations formulated, and to check their application.

The requirement for inclining various classes of ships has resulted in obtaining safer conditions. This result has been accomplished by traveling inspectors of the central office subjecting these vessels to stability tests. This has not been an easy task, and to keep abreast of the great number of tests conducted the inspectors have been required to work long hours and on holidays and Sundays. Additional men are necessary for this work.

If a fire occurs on a vessel while at her dock, help may be obtained from the city fire-fighting apparatus, but the real problem to be faced by the officers of a ship is the ability to fight a fire by themselves. At the last meeting of the Board of Supervising Inspectors in January 1931, the board enacted a very important rule providing that—

> On and after July 1, 1931, all passenger vessels shall be fitted above the bulkhead deck with fire-resisting bulkheads which shall be continuous from side to side of the vessel and arranged to the satisfaction of the Steamboat Inspection Service.
>
> These bulkheads shall be constructed of fire-resisting material effective to prevent for one hour, under the conditions for which the bulkheads are to be fitted in the vessel, the spread of fire generating a temperature of 1,500° F. at the bulkhead.

This rule was intended to bring the new tonnage of this country abreast of the standard established by the conference at London in 1929. Its application is a big step forward in the direction of safety and is one that is being favorably accepted by naval architects and owners of vessels. The regulations should go further. In the annual report for the fiscal year ended June 30, 1927, it was pointed out that the time was at hand when naval architects should give attention to the building of excursion steamers that were fireproof. The same holds true with reference to ferry steamers. At the next meeting of the Board of Supervising Inspectors in January, 1932, particular attention will be given to these classes of vessels.

BOILERS AND MACHINERY

Statutes were enacted many years ago covering the material for boilers and their construction and inspection. It is apparent that such laws had their origin in the desire for safety. That need for safety is still as great as when the statutes were enacted, if not greater, but practices resulting from modern developments have made it necessary to make many amendments, thereby affording greater elasticity for future changes. Before additional legislation can be recommended, it is necessary to complete the drafting of a boiler code that has been in progress for several years. It is hoped this work will be finished before the end of the fiscal year 1932. When it is completed, and the necessary legislation is enacted to make the code workable, the regulations of the United States covering boilers and machinery will be second to none in the world. In putting into effect this new boiler code, it will be desirable to have the plans of boilers, etc., reviewed in the central office. This will, of course, require a force of men specially trained in boiler construction.

SHIPS' PERSONNEL

EXAMINATIONS FOR LICENSES

Representative standard examinations have been used for some time, resulting in a greater degree of uniformity in the examination of officers for vessels than was previously possible. However, the ideal condition can not be obtained until the experience of the applicants and the examination papers as well, are checked in the central office. Without this check it is easy to see how 47 different boards of local inspectors, situated in 47 different sections of the country, can reach 47 different conclusions. Under the present system, incorrect action can be remedied only by appeal, and the central office should be in a position to know that all original action was correct. This work would, of course, require a specially trained force, but it would insure greater uniformity and a higher grade of ships' personnel.

OFFICERS AND CREW

The complement of officers and crew required on vessels should also be checked to determine whether all vessels of the same class navigating upon similar waters in the same kind of trade are required to have the same number of officers and crew. This work would require trained personnel.

ACTION AGAINST LICENSES

It is desired that uniform penalties be imposed on officers for like offenses when different boards of local inspectors conduct investigations and trials. It will require checking in the central office to see that sentences are correct and uniform. This work, if done, will require additional personnel.

LESSONS LEARNED FROM DISASTERS

Thoughts of disasters are appalling and distressing. But regardless of how seaworthy a ship may be, how specially qualified the officers and crew may be, or how earnest is the endeavor to avoid accidents, they do occur. Sometimes they occur through error of judgment; sometimes through carelessness and inattention to duty; and sometimes through causes unknown. In the case of accidents occurring through carelessness and inattention to duty, corrective action is taken by attacking the licenses of officers found guilty. Where the cause is unknown, it should be possible to find it, and it is believed this could be done if this bureau had sufficient personnel to review all the known circumstances. This would require time and expense, but the lessons thus learned would more than justify the effort and expense. In the case of disasters to the car ferries on the Great Lakes, it was found desirable to raise the height of the sea gates, and this has been and is being done. Weekly examinations of these car ferries have indicated that there has been a material improvement in the conditions.

EXPENDITURES

Salaries, office of the Supervising Inspector General and field force	$1, 133, 238. 34
Traveling expenses (actual)	92, 012. 80
Rents, offices	32, 426. 42
Furniture, instruments, stationery, supplies, and transportation of same	5, 925. 21
Telephone rents and telegrams	6, 999. 03
Witness fees and mileage in cases of investigation	155. 80
Ice, fuel, and electric light	362. 44
Toilet service, laundry, soap, etc	272. 04
Janitor service	150. 00
Notarial certifications	516. 44
Repairs	230. 58
Miscellaneous	1, 196. 83
Total traveling and miscellaneous expenses	140, 247. 59
Salaries, 1931	1, 133, 238. 34
Salaries, 1930	1, 024, 943. 49
Increase, 1931	108, 294. 85
Contingent expenses, 1931	140, 247. 59
Contingent expenses, 1930	151, 991. 16
Decrease, 1931	11, 743. 57
Rents, 1931	32, 426. 42
Rents, 1930	31, 836. 37
Increase, 1931	590. 05
Traveling expenses, 1931	92, 012. 80
Traveling expenses, 1930	94, 308. 00
Decrease, 1931	2, 295. 20
Total traveling and miscellaneous expenses as noted above	140, 247. 59
Total salaries as noted above	1, 133, 238. 34
Total expenditures for year ended June 30, 1931	1, 273, 485, 93
Total expenditures for year ended June 30, 1930	1, 176, 934. 65
Increase, 1931	96, 551. 28

The above increase is due to increase in force.

HULLS AND EQUIPMENT STATISTICS

VESSELS INSPECTED AND CERTIFICATES OF INSPECTION ISSUED TO STEAM AND MOTOR VESSELS AND TO BARGES

CERTIFICATES OF INSPECTION ISSUED BY DISTRICTS

Supervising 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	344	1,170,791	110	84,495			7	14,461	461	1,269,747	34	246,656	495	1,516,403
	Honolulu, Hawaii	17	46,381	4	722			2	877	23	47,980	24	345,416	47	393,396
	Los Angeles, Calif	71	309,228	19	29,051			1	434	91	338,713	6	42,967	97	381,680
	Portland, Oreg	61	122,416	15	1,667	1	538			77	124,621	1	10,220	78	134,841
Second	New York, N. Y	1,299	2,446,232	167	181,835	2	1,822	118	125,427	1,586	2,755,316	153	2,663,101	1,739	5,418,417
	Albany, N. Y	90	19,505	14	7,193					104	26,698	2	188	106	26,886
	New Haven, Conn	34	6,314	30	1,360					64	7,674			64	7,674
	Philadelphia, Pa	231	510,076	75	188,639			51	44,962	357	743,677			357	743,677
Third	Norfolk, Va	139	181,636	134	7,809	2	620	60	56,554	335	246,619			335	246,619
	Baltimore, Md	241	614,278	125	32,961			8	7,590	374	654,829			374	654,829
	Charleston, S. C	26	16,080	39	1,490			2	3,435	67	21,005	1	2,499	68	23,504
	Jacksonville, Fla	22	44,662	54	2,681			8	6,705	84	54,048			84	54,048
	Savannah, Ga	28	61,029	4	134			4	4,354	36	65,517			36	65,517
Fourth	St. Louis, Mo	67	17,896	23	801					90	18,697			90	18,697
	Dubuque, Iowa	30	6,576	34	1,149					64	7,725			64	7,725
Fifth	Boston, Mass	177	503,552	14	12,999			15	14,129	206	530,680	16	99,092	222	629,772
	Bangor, Me	6	4,133	25	782			4	4,049	35	8,964	3	1,947	38	10,911
	New London, Conn	20	17,871	18	1,210			4	5,444	51	24,525			51	24,525
	Portland, Me	34	28,612	15	1,840			8	5,689	57	36,141			57	36,141
	Providence, R. I	44	76,861	10	2,938			9	10,553	63	90,352			63	90,352
Sixth	Louisville, Ky	22	5,263	8	997					30	6,260			30	6,260
	Evansville, Ind	23	6,127	10	606	1	139			34	6,872			34	6,872
	Memphis, Tenn	48	10,496	8	353					56	10,849			56	10,849
	Nashville, Tenn	40	5,612	3	148					43	5,760			43	5,760
Seventh	Pittsburgh, Pa	65	19,241	13	961	2	583			80	20,785			80	20,785
	Cincinnati, Ohio	20	5,976	5	192					25	6,168			25	6,168
	Point Pleasant, W. Va	28	6,320	6	133	1	109			35	6,562			35	6,562
Eighth	Detroit, Mich	79	161,346	13	25,082					92	186,428	2	2,622	94	189,050
	Chicago, Ill	95	315,387	7	7,636					102	323,023			102	323,023
	Duluth, Minn	44	134,653							44	134,653	1	245	45	134,898
	Grand Haven, Mich	34	37,858	7	337					41	38,195			41	38,195
	Marquette, Mich	21	9,896	2	94					23	9,990	2	1,111	25	11,101
	Milwaukee, Wis	66	154,816	11	1,345					77	156,161			77	156,161
	Port Huron, Mich	22	24,373	6	946					28	25,319	3	15,499	31	40,818

VESSELS INSPECTED AND CERTIFICATE OF INSPECTION ISSUED TO STEAM AND MOTOR VESSELS AND BARGES—continued

CERTIFICATES OF INSPECTION ISSUED BY DISTRICTS—Continued

Supervising 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
Ninth	Cleveland, Ohio	100	343,274	3	7,794					103	351,068			103	351,068
	Buffalo, N. Y	187	534,813	5	4,955	2	233			194	540,001	10	22,964	204	562,965
	Oswego, N. Y	21	14,096	9	481					30	14,577	7	2,235	37	16,812
	Toledo, Ohio	72	249,054	4	377					76	249,431			76	249,431
Tenth	New Orleans, La	221	577,236	41	2,851	5	5,909	2	2,584	269	588,580	18	92,874	287	681,454
	Galveston, Tex	100	366,259	12	23,635	1	945	23	31,233	136	422,072	9	85,118	145	507,190
	Mobile, Ala	93	216,082	20	784			7	10,946	120	227,812			120	227,812
	San Juan, P. R	11	25,524	6	119					17	25,643	12	53,577	29	79,220
	Tampa, Fla	16	27,165	13	1,131					29	28,296			29	28,296
Eleventh	Seattle, Wash	144	336,537	64	27,482	2	319	1	979	211	365,317	44	300,098	255	665,415
	Hoquiam, Wash	7	398	1	22					8	420			8	420
	Juneau, Alaska	7	504	21	1,938			1	1,809	29	4,251			29	4,251
	St. Michael, Alaska	5	1,492	10	512					15	2,004	6	5,416	21	7,420
	Total, 1931	4,581	9,793,927	1,237	672,667	19	11,217	335	352,214	6,172	10,830,025	354	3,993,845	6,526	14,823,870
	Total, 1930	5,062	11,075,836	1,152	599,912	19	10,969	367	392,638	6,600	12,079,355	334	3,696,023	6,934	15,775,378
	Increase (+) or decrease (−)	−481	−1,281,909	+85	+72,755		+248	−32	−40,424	−428	−1,249,330	+20	+297,822	−408	−951,508

VESSELS INSPECTED, BY GEOGRAPHIC DIVISIONS

Pacific coast	656	1,987,747	244	145,889	3	857	12	18,560	915	2,153,053	115	950,773	1,030	3,103,826
Atlantic coast	2,411	4,556,365	730	443,990	4	2,442	291	288,891	3,436	5,291,688	187	2,820,404	3,623	8,112,092
Western rivers	343	83,507	110	5,340	4	831			457	89,678			457	89,678
Great Lakes	741	1,979,566	67	49,047	2	233			810	2,028,846	25	44,676	835	2,073,522
Gulf coast	430	1,186,742	86	28,401	6	6,854	32	44,763	554	1,266,760	27	177,992	581	1,444,752
Total, 1931	4,581	9,793,927	1,237	672,667	19	11,217	335	352,214	6,172	10,830,025	354	3,993,845	6,526	14,823,870
Total, 1930	5,062	11,075,836	1,152	599,912	19	10,969	367	392,638	6,600	12,079,355	334	3,696,023	6,934	15,775,378
Increase (+) or decrease (−)	−481	−1,281,909	+85	+72,755		+248	−32	−40,424	−428	−1,249,330	+20	+297,822	−408	−951,508

MISCELLANEOUS INSPECTIONS

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.

Local inspection distruct (port)	Steam vessels granted letters of approval		Government vessels inspected	Government boilers inspected
	Number	Gross tonnage		
San Francisco, Calif.	------	-------	--------	42
Honolulu, Hawaii	------	-------	--------	36
Los Angeles, Calif.	------	-------	1	40
Portland, Oreg.	------	-------	--------	49
New York, N. Y.	------	-------	14	152
Albany, N. Y.	------	-------	--------	14
New Haven, Conn.	------	-------	--------	11
Philadelphia, Pa.	------	-------	--------	56
Norfolk, Va.	------	-------	1	68
Baltimore, Md.	------	-------	--------	155
Charleston, S. C.	------	-------	3	42
Jacksonville, Fla.	------	-------	--------	20
Savannah, Ga.	------	-------	--------	16
St. Louis, Mo.	1	28	--------	232
Dubuque, Iowa	1	14	2	74
Boston, Mass.	------	-------	1	66
New London, Conn.	------	-------	--------	13
Portland, Me.	------	-------	--------	9
Louisville, Ky.	------	-------	--------	60
Evansville, Ind.	------	-------	--------	18
Memphis, Tenn.	1	48	--------	147
Nashville, Tenn.	------	-------	--------	52
Pittsburgh, Pa.	------	-------	1	137
Cincinnati, Ohio	------	-------	--------	61
Point Pleasant, W. Va.	------	-------	--------	63
Detroit, Mich.	------	-------	--------	19
Chicago, Ill.	------	-------	--------	37
Duluth, Minn.	------	-------	3	11
Grand Haven, Mich.	4	111	1	18
Marquette, Mich.	------	-------	1	11
Milwaukee, Wis.	2	113	5	20
Cleveland, Ohio	------	-------	3	4
Buffalo, N. Y.	2	13	3	4
Oswego, N. Y.	------	-------	--------	12
Toledo, Ohio	------	-------	--------	9
New Orleans, La.	------	-------	33	186
Galveston, Tex.	------	-------	--------	79
Mobile, Ala.	------	-------	7	124
San Juan, P. R.	------	-------	--------	2
Tampa, Fla.	------	-------	2	3
Seattle, Wash.	1	75	--------	30
Hoquiam, Wash.	------	-------	--------	3
Juneau, Alaska	------	-------	9	--------
Total, 1931	12	402	90	2,205
Total, 1930	14	1,179	96	2,203
Increase (+) or decrease (−)	−2	−777	−6	+2

REINSPECTIONS

Local inspection district (port)	Steam vessels	Motor vessels	Barges, etc.	Total
San Francisco, Calif.	233	78	--------	311
Los Angeles, Calif.	23	4	--------	27
Portland, Oreg.	13	1	--------	14
New York, N. Y.	1,058	131	3	1,192
Albany, N. Y.	52	26	--------	78
New Haven, Conn.	20	49	--------	69
Philadelphia, Pa.	201	50	--------	251
Norfolk, Va.	61	-------	--------	61
Baltimore, Md.	86	5	--------	91
Charleston, S. C.	------	2	--------	2
Jacksonville, Fla.	28	44	--------	72
Savannah, Ga.	24	3	--------	27
St. Louis, Mo.	15	1	--------	16
Dubuque, Iowa	7	-------	--------	7
Boston, Mass.	81	-------	--------	81
Bangor, Me.	13	9	2	24
New London, Conn.	14	23	--------	37
Portland, Me.	53	-------	--------	53
Providence, R. I.	47	7	--------	54
Louisville, Ky.	7	-------	--------	7
Evansville, Ind.	8	12	--------	20
Memphis, Tenn.	4	-------	--------	4
Nashville, Tenn.	8	-------	--------	8
Pittsburgh, Pa.	12	-------	--------	12
Cincinnati, Ohio	32	-------	--------	32
Point Pleasant, W. Va.	13	-------	--------	13
Detroit, Mich.	83	16	--------	99
Chicago, Ill.	34	8	--------	42
Duluth, Minn.	18	-------	--------	18
Grand Haven, Mich.	65	4	--------	69
Marquette, Mich.	25	3	--------	28
Milwaukee, Wis.	18	8	--------	26
Port Huron, Mich.	19	12	--------	31
Cleveland, Ohio	12	-------	--------	12
Buffalo, N. Y.	48	-------	2	50
Oswego, N. Y.	19	30	--------	49
Toledo, Ohio	17	5	--------	22
New Orleans, La.	141	43	14	198
Galveston, Tex.	18	19	3	40
Mobile, Ala.	14	5	--------	19
San Juan, P. R.	15	4	--------	19
Tampa, Fla.	12	6	--------	18
Seattle, Wash.	145	50	--------	195
Juneau, Alaska	------	3	--------	3
Total, 1931	2,816	661	24	3,501
Total, 1930	2,104	357	16	2,477
Increase	712	304	8	1,024

CERTIFICATES WITHDRAWN OR REFUSED

Vessels from which certificates of inspection were withdrawn	5
Vessels refused certificates of inspection:	
Domestic steam vessels	66
Domestic vessels propelled by gas, fluid, naphtha, or electric motor	11
Domestic vessels and barges of over 100 gross tons carrying passengers for hire, other than steam, motor, and sail vessels	1
Total	83

CARGO VESSELS EXAMINED TO CARRY PERSONS IN ADDITION TO CREW

During the year ended June 30, 1931, 1,004 cargo vessels were examined to carry persons in addition to crew, under the provisions of the act of Congress approved June 5, 1920.

NEW LIFE PRESERVERS INSPECTED

Kind	Inspected	Passed	Rejected
Block cork	112,132	111,344	788
Balsa block	8,830	8,812	18
Kapok	116	116	
Total, 1931	121,078	120,272	806
Total, 1930	208,604	207,221	1,383
Decrease	87,526	86,949	577

LIFE-SAVING APPARATUS INSPECTED AT FACTORIES

Kind	Inspected	Passed	Rejected
New cork-ring life buoys	5,427	5,389	38
New balsa wood life buoys	517	513	4
New lifeboats	502	502	
New life rafts	263	263	
New boat davits	337	337	

WORK PERFORMED BY INSPECTORS IN CENTRAL OFFICE

Vessels inclined	106
Reinspections of vessels	171

BOILERS

Boilers inspected:	
Steel (riveted plates)	9,457
Iron (riveted plates)	68
Pipe	2,444
Total	11,969
Boilers found defective:	
Gave way under hydrostatic pressure—	
Steel (riveted plates)	206
Iron (riveted plates)	3
Pipe	6
Total	215

Boilers found defective—Continued.	
Defective from other causes—	
Steel (riveted plates)	1,570
Iron (riveted plates)	16
Pipe	177
Total	1,763
Boilers condemned from further use:	
Steel (riveted plates)	14
Iron (riveted plates)	1
Pipe	4
Total	19
Defects in boilers and attachments:	
Sheets	1,094
Heads	429
Steam and mud drums	77
Flues and tubes	60,960
Steam pipes	243
Stay bolts	20,129
Braces	367
Other parts	18,825
Total	102,124
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	2
Tests of samples of steel bars to be used as stays and braces: Samples tested	28
Total	30

MARINE-BOILER PLATES TESTED

Inspected by assistant inspectors at—	Plates rejected because of—									Total		
	Tensile strength	Surface defect	Light gauge	Heavy gauge	Lost	Bend test	Spoiled at shears	Lamination	Elongation	Rejected	Accepted	Inspected
Coatesville, Pa	13	8	6	----	----	----	1	----	----	28	911	939
Philadelphia, Pa	4	2	2	----	----	----	----	----	----	8	145	153
Pittsburgh, Pa	4	3	----	1	----	----	----	20	----	28	836	864
Chicago, Ill	6	----	----	----	----	1	----	----	----	7	204	211
Cleveland, Ohio	----	5	----	----	----	----	----	3	----	8	342	350
Total, 1931	27	18	8	1	----	1	1	23	----	79	2,438	2,517
Total, 1930	43	29	13	1	2	8	2	3	3	104	3,102	3,206
Increase (+) or decrease (−)	−16	−11	−5	----	−2	−7	−1	+20	−3	−25	−664	−689

STEEL BARS AND FORGINGS TESTED

Tested by assistant inspectors at—	Samples of bars		Samples of forgings		Bars		Forgings	
	Tested	Rejected	Tested	Rejected	Accepted	Rejected	Accepted	Rejected
Coatesville, Pa	36	1	16	----	186	----	4	----
Pittsburgh, Pa	40	----	----	----	274	16	----	----
Chicago, Ill	28	----	----	----	108	----	----	----
Total, 1931	104	1	16	----	568	16	4	----

STATISTICS CONCERNING SHIP'S PERSONNEL

OFFICERS LICENSED

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	365	238	40	7	5	364	305	157	407	45	4		1,937
Honolulu, Hawaii	26	14			1	16	14	7	53	5	1		137
Los Angeles, Calif	110	68	2	7	6	87	79	54	412	9	2		836
Portland, Oreg	51	17	11	1	3	48	52	24	216	6			429
New York, N. Y	1,080	496	50	118	3	1,413	730	354	1,118	43	3	3	5,411
Albany, N. Y	47	3	13	23	14	89	20	20	55				284
New Haven, Conn	27	7	2	12	3	15	5	15	145				231
Philadelphia, Pa	189	140	7	18	5	245	137	90	741	13			1,585
Norfolk, Va	99	34	3	24	8	119	58	44	595	3			987
Baltimore, Md	208	88	13	15	20	200	128	67	371	6	2		1,118
Charleston, S. C	22	7		10	5	19	13	16	126	4			222
Jacksonville, Fla	58	18	4	3	5	36	52	43	466	5			690
Savannah, Ga	27	10	3	8		25	21	13	51				158
St. Louis, Mo	28		25	37	1	52	13	11	370				537
Dubuque, Iowa	8		7	9		16	5	9	91				145
Boston, Mass	148	182	9	24	4	176	149	37	310	19	1		1,059
Bangor, Me	18	17	1	1	2	18	9	7	102	5			180
New London, Conn	29	11	4	3	1	32	10	26	193	4			313
Portland, Me	39	40	3	3	5	47	20	7	135	12			311
Providence, R. I	39	25	5	4	2	44	17	12	133	3			284
Louisville, Ky	13		4	7		23	10	8	43				108
Evansville, Ind	13		3	5	1	13	4	2	103				144
Memphis, Tenn	16		4	9	1	29	2	1	69				131
Nashville, Tenn	14		4	8	1	15	2	1	46				91
Pittsburgh, Pa	31		18	5	1	40	10	2	87				194
Cincinnati, Ohio	21		14	8		15	5	4	50				117
Point Pleasant, W. Va	10	1	6	6		17	3	4	51				98
Detroit, Mich	71	4		22	2	70	45	12	62				288
Chicago, Ill	40	9		20	6	58	43	20	159				355
Duluth, Minn	15			19	3	19	10	1	32				99
Grand Haven, Mich	23			11	5	42	22		86				189
Marquette, Mich	8			11	2	16	7	2	87				133
Milwaukee, Wis	61	1		33	5	68	56	12	54				290
Port Huron, Mich	46			20	2	54	48	2	24				196
Cleveland, Ohio	70	3		59	1	110	70	15	102				430

Buffalo, N. Y.	53			37	8	102	47	13	117				377
Oswego, N. Y.	17		3	11	6	20	5	5	159				226
Toledo, Ohio	24	1		11		27	7	5	72				147
New Orleans, La.	189	102	14	27	23	228	134	78	150	7	1		953
Galveston, Tex.	76	62		6	11	95	46	37	240	1			574
Mobile, Ala.	53	34	3	7	8	76	30	20	146	8			385
San Juan, P. R.	11	4		6	9	8	4	10	37				89
Tampa, Fla.	22	16	3	2	1	19	22	31	193	3			312
Seattle, Wash.	181	89	35		4	113	92	89	312	17	1		933
Hoquiam, Wash.	30	25	8			10	8	5	11	3			100
Juneau, Alaska	11	7	6	3	3	6	6	24	169	1			236
St. Michael, Alaska	5	1	1			3	3	4	35	1			53
Total, 1931	3,742	1,774	328	680	196	4,357	2,578	1,420	8,786	223	15	3	24,102
Total, 1930	3,902	2,002	310	733	216	4,421	3,011	1,531	7,871	301	10	4	24,312
Increase (+) or decrease (−)	−160	−228	+18	−53	−20	−64	−433	−111	+915	−78	+5	−1	−210

RESULTS OF ACTION AGAINST LICENSES

Licenses suspended	168
Licenses revoked	8
Licenses refused	182
Licenses canceled	37
Violations of the law:	
Cases investigated	1,125
Cases dismissed	835
Cases reported to district attorneys and chief officers of customs	148
Number of appeals from decisions of local boards	25
Decisions of local boards reversed by supervising inspectors	9
Decisions of local boards modified by supervising inspectors	8
Decisions of local boards sustained by supervising inspectors	8

EXAMINATIONS FOR COLOR BLINDNESS

During the year ended June 30, 1931, 6,821 applicants for original licenses and for renewals of licenses were examined for visual defects, 74 of whom were found color blind, or had other visual defects, and were rejected, and 6,747 were passed. As compared with the previous year, these figures show a decrease of 502 in the number examined and of 535 in the number passed.

CERTIFICATES OF SERVICE ISSUED TO ABLE SEAMEN AND TO LIFEBOAT MEN

ABLE SEAMEN

Issued by—	Applications received	Applications rejected	Certificates issued	Issued by—	Applications received	Applications rejected	Certificates issued
INSPECTION DISTRICT				INSPECTION DISTRICT—continued			
San Francisco, Calif.	614	50	564	Marquette, Mich.	17	1	16
Honolulu, Hawaii	113	7	106	Milwaukee, Wis.	94	3	91
Los Angeles, Calif.	211	8	203	Port Huron, Mich.	36	9	27
Portland, Oreg.	74	21	53	Cleveland, Ohio	208	37	171
New York, N. Y.	1,811	103	1,708	Buffalo, N. Y.	144	11	133
New Haven, Conn.	5		5	Oswego, N. Y.	5	1	4
Philadelphia, Pa.	357	20	337	Toledo, Ohio	50	10	40
Norfolk, Va.	166	5	161	New Orleans, La.	412	28	384
Baltimore, Md.	666	116	550	Galveston, Tex.	113	6	107
Charleston, S. C.	34	3	31	Mobile, Ala.	111	13	98
Jacksonville, Fla.	157	15	142	San Juan, P. R.	15	2	13
Savannah, Ga.	77	10	67	Tampa, Fla.	50	1	49
Boston, Mass.	307	26	281	Seattle, Wash.	381	7	374
Bangor, Me.	23		23	Hoquiam, Wash.	12	1	11
New London, Conn.	17		17	Juneau, Alaska	10		10
Portland, Me.	55	2	53	St. Michael, Alaska	4		4
Providence, R. I.	115	23	92				
Detroit, Mich.	214	46	168	Total, 1931	6,901	607	6,294
Chicago, Ill.	151	13	138	Total, 1930	8,851	902	7,949
Duluth, Minn.	55	5	50				
Grand Haven, Mich.	17	4	13	Decrease	1,950	295	1,655

CERTIFICATES OF SERVICE ISSUED TO ABLE SEAMEN AND TO LIFEBOAT MEN—continued

LIFEBOAT MEN

Issued by—	Applications received	Applications rejected	Certificates issued
Local inspectors of vessels:			
San Francisco, Calif.	194		194
Los Angeles, Calif.	96		96
Portland, Oreg.	13		13
New York, N. Y.	345		345
Albany, N. Y.	6		6
New Haven, Conn.	15		15
Philadelphia, Pa.	48		48
Norfolk, Va.	27		27
Baltimore, Md.	195		195
Charleston, S. C.	3		3
Jacksonville, Fla.	249		249
Savannah, Ga.	73	5	68
St. Louis, Mo.	1		1
Boston, Mass.	154		154
Bangor, Me.	35		35
New London, Conn.	35		35
Portland, Me.	53		53
Providence, R. I.	139		139
Detroit, Mich.	187		187
Chicago, Ill.	8		8
Duluth, Minn.	2		2
Grand Haven, Mich.	1		1
Milwaukee, Wis.	14		14
Port Huron, Mich.	6		6
Cleveland, Ohio	35	5	30
Buffalo, N. Y.	8		8
Toledo, Ohio	22		22
New Orleans, La.	59		59
Galveston, Tex.	19		19
Mobile, Ala.	24		24
San Juan, P. R.	1		1
Tampa, Fla.	82		82
Local inspectors of vessels—Continued.			
Seattle, Wash.	4,942	3,174	1,768
Hoquiam, Wash.	13	2	11
Juneau, Alaska	80	1	79
St. Michael, Alaska	8		8
Total by local inspectors	7,192	3,187	4,005
Navy Department:			
Navy yards—			
New York, N. Y.	224	122	102
Portsmouth, Va.	375	53	322
Receiving station, Philadelphia, Pa.	346	103	243
U. S. Coast Guard, Treasury Department	5,525	1,659	3,866
Coast and Geodetic Survey, Department of Commerce	22		22
Bureau of Lighthouses, Department of Commerce	931	701	230
Massachusetts nautical school ship Nantucket	30		30
New York State Merchant Marine Academy	21		21
Total, 1931	14,666	5,825	8,841
Total, 1930	14,546	6,231	8,315
Increase (+) or decrease (−)	+120	−406	+526

TRANSPORTATION AND LOSS OF LIFE

PASSENGERS CARRIED

During the fiscal year 305,219,538 passengers were carried on vessels that are required by law to report the number of passengers carried. Dividing this number by 71, the total number of passengers lost, shows that 4,298,866 were carried for each passenger lost. In connection with the prevention of overloading of vessels, 1,349,040 passengers were counted during the year by representatives of this service.

LIVES SAVED

During the year, 1,065 lives were directly saved by means of the life-saving appliances required by law.

LIVES LOST ON VESSELS SUBJECT TO INSPECTION

Cause	First		Second		Third		Fourth		Fifth		Sixth	
	Passengers	Crew	Passengers	Crew	Passengers	Crew	Passengers	Crew	Passengers	Crew	Passengers	Crew
Fire: Passenger steamers					3	1						
Collision:												
Passenger steamers				1								
Nonpassenger steamers				2								
Grounding: Nonpassenger steamers										1		
Explosion, escape of steam, etc.: Nonpassenger steamers				9		5						3
Sinking: Nonpassenger steamers				2								
Accidental drowning:												
Passenger steamers		2	1	3		1					1	
Nonpassenger steamers		2		9		6				1		2
Suicide:												
Passenger steamers	23		14	2	2				3			
Nonpassenger steamers		1		2						1		
Foundered: Nonpassenger steamers		18										
Wrecked: Nonpassenger steamers		19										
Miscellaneous:												
Passenger steamers	9	4	2	6	1	1		1			1	
Nonpassenger steamers		9		22		2				5		1
Total:												
Passenger steamers	32	6	17	12	6	3		1	3		2	
Nonpassenger steamers		49		46		13				8		6
Grand total	32	55	17	58	6	16		1	3	8	2	6
Last year	73	52	16	61	6	25		5	22	43		5
Increase(+) or decrease(−)	−41	+3	+1	−3		−9		−4	−19	−35	+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			3	2
Collision:												
Passenger steamers												1
Nonpassenger steamers								1		10		13
Grounding: Nonpassenger steamers												1
Explosion, escape of steam, etc.: Nonpassenger steamers				1								18
Sinking: Nonpassenger steamers		1						2				5
Accidental drowning:												
Passenger steamers					2		1				5	6
Nonpassenger steamers		1		1		3		5				30
Suicide:												
Passenger steamers			1				4				47	2
Nonpassenger steamers								2				6
Foundered: Nonpassenger steamers				11		15		5				49
Wrecked: Nonpassenger steamers												19
Miscellaneous:												
Passenger steamers			1	1			2	1			16	14
Nonpassenger steamers				3		5		10		1		58
Total:												
Passenger steamers			2	1	2		7	2			71	25
Nonpassenger steamers		2		16		23		25		11		199
Grant total		2	2	17	2	23	7	27		11	71	224
Last year		2	6	107		12	12	42	1	1	136	355
Increase (+) or decrease (−)			−4	−90	+2	+11	−5	−15	−1	+10	−65	−131

The total number of lives lost from all causes, passengers and crew, was 295, a decrease of 196 over the previous year. Of the lives lost, 184 were from suicide, accidental drowning, and other causes beyond the power of the service to prevent, leaving a loss of 111 fairly chargeable to accidents, collisions, founderings, etc.

ACCIDENTS RESULTING IN LOSS OF LIFE

The total number of accidents resulting in loss of life during the past year was 24, a decrease of 147 from the previous year. Enumerated by supervising inspection districts, accidents occurred as follows: First, 2; second, 8; third, 1; fourth, 0; fifth, 2; sixth, 1; seventh, 1; eighth, 3; ninth, 2; tenth, 3; eleventh, 1.

The following disasters resulted in an unusually large loss of life:

On July 29, 1930, the steamer *George J. Whelan*, 1,289 gross tons, while en route from Sandusky, Ohio, to Tonawanda, N. Y., loaded with 1,611 tons of crushed stone, rolled over and foundered on Lake Erie, about 23 miles east of Presque Isle Light. Fifteen lives were lost. Vessel valued at $175,000. The case was investigated and dismissed by the local inspectors at Buffalo, N. Y.

On September 1, 1930, the steamer *Admiral Nulton*, 3,545 gross tons, and the fishing vessel *Orient*, 57 gross tons, collided one-half mile N.-NW. magnetic from Sisters Island Light, British Columbia, which accident resulted in the sinking of the *Orient*. Ten lives were lost. The case was investigated by the local inspectors at San Francisco, Calif., and Lee G. Clements, second mate of the *Admiral Nulton* was charged with unskillfulness, violation of section 4440, R. S. Jurisdiction was transferred to Seattle, Wash., where the local inspectors concluded the charge was not sustained.

On September 16, 1930, the steamer *South Coast*, 301 gross tons, left the port of Crescent City, Calif., bound for Coos Bay, Oreg., and has never been heard from since. Wreckage proved that this steamer was battered to pieces on the rocks, but actual cause is not known, as there are no survivors. Nineteen lives were lost. Vessel valued at $20,000. The case was investigated and dismissed by the local inspectors at San Francisco, Calif.

On September 26, 1930, the motor vessel *North Shore*, 63 gross tons, left Benton Harbor, Mich., for Milwaukee, Wis., and when it failed to arrive a search was instituted and wreckage was found floating on the Lake 30 miles northeast of Racine, Wis. No further trace of the vessel has ever been found. Entire crew of six was lost. Estimated loss $14,000. The case was investigated and dismissed by the local inspectors at Milwaukee, Wis.

On November 8, 1930, the steamer *Brooklyn*, 333 gross tons, crossing out over Eureka Bar, encountered heavy breaking seas which filled the engine and boiler room, extinguishing the fires and rendering the vessel helpless. It drifted up the coast for 3 miles where it beached and was pounded to pieces by the heavy surf. The entire crew of 18 persons and 1 stowaway were washed overboard and lost, with the exception of the chief mate. Vessel valued at $15,000. The case was investigated and dismissed by the local inspectors at San Francisco, Calif.

VESSELS LOST

Steam vessels	41
Motor vessels	11
Sail vessels	2
Barges, etc	15
Total	69

PROPERTY LOST

By explosion or accidental escape of steam	$46, 545
By wreck or founder	2, 515, 304
By collision between vessels	2, 488, 046
By fire	1, 466, 835
By snags	153, 361
From miscellaneous causes	3, 319, 507
Total	9, 989, 598

Very truly yours,

DICKERSON N. HOOVER,
Supervising Inspector General.

PATENT OFFICE

DEPARTMENT OF COMMERCE,
UNITED STATES PATENT OFFICE,
Washington, July 1, 1931.

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, 1931:

The year just closed has been a very busy one in the Patent Office. At the close of the preceding fiscal year the number of patent applications awaiting official action had reached 119,597, but with the 110 additional employees provided by Congress the applications have been acted upon so much more expeditiously that the arrears at the close of the present fiscal year number 92,203, a reduction during the year of 27,394. Seven years ago the office made a record by reducing the arrears 15,778 applications in one year with an increase of 100 examiners, but during the past year that record reduction of arrears (with a similar increase of examiners) has been exceeded by over 11,000 applications. It is gratifying to note that in making this reduction of 27,000 in pending applications there has been a corresponding decrease in the time that applicants are compelled to await action on their applications for patents, the average time being reduced nearly 3 months. This is illustrated by the following: On June 30, 1930, of the 63 patent-examining divisions, there were only 3 divisions under 6 months; now there are 1 under 2 months, 3 under 3 months, 6 under 4 months, 18 under 5 months, and 41 under 6 months. There were then 33 divisions out of the 63 over 9 months and 1 over 10 months; now each division is under 8 months. During the summer vacation period, when so many of the employees are absent it is impossible to make any gains, but by September the force will again begin to make substantial gains and further reduce both the number of pending applications and the time an applicant must await official action.

The new system of supervision, recommended by the Cleveland Patent Law Association and approved in modified form by the United States Bureau of Efficiency, has now been in operation for a year and is giving very beneficial results. Under this system four well equipped principal examiners were relieved from their duties as examiners to form a supervisory board. As set forth in my last annual report, these supervisors have established closer supervision of the work of the 63 examining divisions by unifying and integrating the work, by maintaining a well-organized system of training for new examiners, by cooperating with the commissioner in forming a board of promotions, and by making certain other changes in the methods of procedure. Members of the bar from various sections of the country give assurance that they can see a marked improvement in the character of the official actions made under the guidance of this board of supervisors. This board is now considered a permanent feature of the office administration.

The increase in the membership of the board of appeals has enabled it to make material advances in its work. This board has now reduced the number of appeals awaiting action from 3,408 to 2,719, a gain of 689 cases. In other words, while 357 interference appeals and 2,519 ex parte appeals, a total of 2,876, were made to this board during the year, the board actually decided 495 interference cases and 3,070 ex parte cases. This has resulted in the time that an applicant has to await the outcome of his appeal being reduced by more than one-half. The large volume of work accomplished by the board of appeals may be seen from the fact that whereas during the year only 185 appeals were made from this office to the United States Court of Customs and Patent Appeals, the board received, as above stated, a total of 2,876 appeals. While the ratio of these appeals to the number of cases acted upon by the examiners has remained about the same, the total number of appeals has thus risen along with the increased number of actions by the enlarged examining corps. The board of appeals is also making every effort to decide cases very promptly after the appeals have been heard. This is both gratifying to applicants and an economy of time of the board.

The incoming new applications have decreased during the year from the "peak year," 1930, when patent applications with fees numbered 91,430 and all applications numbered 117,790, to 84,097 for the patent applications and 106,893 for all applications. The amendments to the applications, however, have increased, due to the necessary response of the applicants to the greater activity of our enlarged examining corps—the number of amendments in patent applications having increased from 217,084 in 1930 to 227,748 in 1931, an increase of over 10,000.

The incoming work of the trade-mark division has also suffered a decrease, due partially to an increase of fees and to a change in practice in trade-mark applications resulting from decisions of the United States Court of Customs and Patent Appeals which prohibit the office from registering many trade-marks which were registrable under the decisions of the Court of Appeals of the District of Columbia, which had jurisdiction of appeals from the Patent Office until recently.

The receipt of fees for the last year has exceeded any year in the history of the Patent Office. Effective June 1, 1930, Congress increased the fees with the expectation that the office would be self-supporting. This anticipation would have been realized had the office received as many new applications during the past year as in 1930. But the decrease of 7,333 new patent applications made a difference of $183,000; a decrease of 3,500 trade-mark applications, a difference of $52,500; a decrease in the number of printed copies sold, a difference of $9,000; and a decrease of 5,000 deeds of assignment, a difference of $15,000. These various items total $259,000, almost equal to the deficit, $266,900.88, for the year. The previous deficits were $608,378 in 1929 and $455,859 in 1930. Moreover, the applications which had been formally "allowed" and in which the applicants failed to pay the final or printing fee numbered 1,635 more than in the previous year, thus causing a loss in revenue of more than $40,000. The total receipts from all sources for this year amounted to $4,565,377.08, whereas the expenditures amounted to $4,832,277.96. Since the largest amount of fees ever before received was in 1930, when the fees amounted to $4,096,825.43, it will be seen that the

receipts this year, amounting to $4,565,377.08, exceeded the previous "peak year" by $468,551.65.

It is interesting to note that during the fiscal year the office received $403,562 from the sale of copies of patents, at 10 cents each, and in all disposed of 6,385,910 of such copies, that the office made 978,955 photostatic copies at a profit of over $80,000, and that the receipts from our recording office amounted to $171,000, the number of deeds of assignment recorded being 52,436.

AIDING INDUSTRY

Except in the radio and moving picture fields, where because of conflicting inventions it is dangerous to make applications "special" in their order of examination, the office for a number of years has made applications "special" where as a prerequisite for taking the case out of its turn and giving it immediate action, affidavits had been placed on file obligating those making the affidavits to expend a certain amount of capital if and only if a patent should be granted, thereby giving employment to labor. Furthermore, such advancement in the order of examination was given to applications only when a pledge was made to report under oath, within three months of the allowance of the application, showing (1) how much money had been expended in the manufacture of the device, (2) the number of devices manufactured, and (3) the extent to which manufacture has increased the employment of labor. During the year about 300 applications were so advanced. This practice of compelling applicants to make a sworn return has not been in practice long enough to afford complete returns, but it is interesting to note some of the returns that have been made. The ones so far reported include the following:

Amount invested	Employment given to—	Amount invested	Employment given to—
$7,000.00	12 employees.	$22,000.00	35 employees.
2,000.00	Orders placed in three different factories, amounting to 1,000,000 springs.	70,000.00	Expects to "involve pay roll of from $180,000 to $600,000 per year."
28,500.00	52 employees.	150,000.00	65 employees.
4,000.00	11 employees.	25,000.00	9 employees.
101,807.00	250 employees.	106,000.00	Pay roll, $4,700.
70,000.00	Number of employees not stated.	12,000.00	3 employees.
4,172.00	Do.	50,000.00	30 employees.
21,000.00	Weekly pay roll $355.	25,500.00	20 employees.
183,784.16	Installation not yet complete and employees not stated.	8,000.00	10 employees.
52,634.00	Pay roll, $6,300 per month.	255,290.00	304 employees.
40,000.00	Number of employees not stated. Additional pay roll to date, $6,778.81.	9,400.00	30 employees.
80,000.00	Force has been doubled but number not stated.	27,300.00	25 employees.
		40,000.00	Do.

The foregoing statistics, though covering only a short period of time, emphasize acutely the necessity for bringing the Patent Office up to date so that every application filed may be acted upon promptly. Toward this end the office is bending all of its energies with a fair promise of success as may be seen from the reduction in the last year which, as above stated, was 27,000 applications, and a reduction as compared with last year of almost three months in the average time an applicant must wait for official action.

Following is an appendix giving the usual statistical information.

APPENDIX

STATISTICS

Applications received during the fiscal year ended June 30, 1931 [1]

With fees:		
Applications for patents for inventions	84,097	
Applications for patents for designs	4,147	
Applications for reissues of patents	463	
		88,707
Applications for registration of trade-marks	[2] 15,144	
Applications for registration of labels and prints	2,866	
		18,010
Total, with fees		106,717
Without fees: Applications for inventions (act Mar. 3, 1883)		176
Grand total		106,893

Applications for patents for inventions with fees

Year ended June 30—		Year ended June 30—	
1922	88,243	1927	84,511
1923	77,645	1928	88,482
1924	76,024	1929	87,039
1925	77,926	1930	91,430
1926	80,682	1931	84,097

Applications for patents, including reissues, designs, trade-marks, labels, and prints, with fees

Year ended June 30—		Year ended June 30—	
1922	113,597	1927	113,783
1923	100,724	1928	116,844
1924	99,574	1929	114,496
1925	103,591	1930	117,569
1926	110,030	1931	106,717

Patent applications awaiting action

June 30—		June 30—	
1922	67,367	1927	64,646
1923	72,475	1928	106,575
1924	60,334	1929	103,236
1925	44,556	1930	119,597
1926	43,765	1931	92,203

Patents withheld and patents expired

	1930	1931
Letters patent withheld for nonpayment of final fees	8,320	9,945
Applications allowed awaiting payment of final fees	15,232	24,097
Patents expired	35,057	36,315
Applications in which issue of patent has been deferred under sec. 4885 R. S.	554	355
Applications in process of issue	3,140	3,561

[1] Including applications in which fees were refunded and transferred.
[2] Includes 1,508 applications for the renewal of trade-mark registrations.

Patents granted and trade-marks, labels, and prints registered

	1927	1928	1929	1930	1931
Letters patent	43,244	41,067	43,617	49,599	44,317
Design patents	2,478	2,698	3,201	2,598	3,089
Reissue patents	293	349	329	374	400
Trade-marks	14,858	14,219	14,391	13,897	12,437
Labels	1,782	1,857	1,774	1,610	1,787
Prints	1,074	944	933	723	678
Total	63,729	61,134	64,245	68,801	62,708

Statement of receipts and earnings for the fiscal year ended June 30, 1931

Unearned balance at close of business June 30, 1930			$181,718.79
Receipts for fiscal year ended June 30, 1931	$4,507,140.01		
Receipts from sale of Official Gazette and other publications through Government Printing Office	58,237.07		
Total receipts			4,565,377.08
			4,747,095.87
Earnings:			
Inventions, first fees	$2,098,445.00		
Extra claims	52,296.00		
Reissues	13,830.00		
Designs	46,440.00		
Design extensions	21,815.00		
Trade-marks	225,645.00		
Labels and prints	14,802.00		
Total		2,473,273.00	
Final fees	1,111,200.00		
Extra claims	25,348.00		
Total		1,136,548.00	
Appeals	47,240.00		
Oppositions	7,590.00		
Disclaimers	1,150.00		
Total		55,980.00	
Printed copies, etc	403,562.05		
Photoprints	14,528.25		
Photostats	86,201.10		
Manuscript	90,925.10		
Certified printed copies, etc	10,107.45		
Recording articles of incorporation	767.00		
Recording international trade-marks	10.00		
Registration of attorneys	1,075.00		
Total		607,175.95	
Drawings		25,622.15	
Assignments		171,710.80	
Total		4,470,309.90	
Receipts from sale of Official Gazette, etc		58,237.07	
Total earnings			4,528,546.97
Refunded			37,863.96
Unearned balance June 30, 1931			180,684.94
			4,747,095.87

Expenditures, fiscal year ended June 30, 1931

Salaries		$3,428,909.18
Scientific library		7,902.92
Investigating public use		659.18
Photolithographing:		
Current issue	$72,942.14	
Reproduction	125,721.46	
Photographic printing	18,270.08	
Photostat supplies	38,704.74	
Dry mounts	2,749.99	
Total		258,388.41
Printing and binding:		
Specifications	836,779.11	
Official Gazette	161,284.83	
Indexes	9,761.64	
Total		1,007,825.58
Miscellaneous		60,000.00
Furniture and filing cases		41,671.16
Contingent expenses, including telephones, stationery, postage on foreign mail, etc		26,921.53
Total		4,832,277.96

Receipts and expenditures

Total receipts from all sources	4,565,377.08
Expenditures	4,832,277.96
Deficit	266,900.88
Total net surplus to date	5,616,827.78

Comparative statement

June 30—	Receipts	Expenditures	Surplus
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
1930	4,096,825.43	4,552,685.41	−455,859.98
1931	4,565,377.08	4,832,277.96	−266,900.88

[1] Including increase in compensation (bonus).

Litigated cases

Oppositions instituted	789
Cancellations instituted	185
Interferences declared (including 145 trade-mark)	1,983
Interferences heard (including 324 trade-mark)	621
Interferences disposed of before final hearing (including 784 trade-mark)	2,309
Interferences disposed of after final hearing (including 317 trade-mark)	617
Interferences awaiting decision (including 30 trade-mark)	59

Oldest case awaiting decision, March 19, 1931.

To Board of Appeals:		
Appeals in interference cases		357
Ex parte appeals		2,519
		2,876
Appeals in interference cases disposed of		495
Ex parte appeals disposed of		3,070
		3,565
Interference cases awaiting action		209
Ex parte cases awaiting action		2,510
		2,719
Oldest interference case awaiting action, April 23, 1931.		
Oldest ex parte case awaiting action, April 16, 1931.		
To the commissioner:		
Appeals in trade-mark interferences		12
Appeals in trade-mark oppositions		85
Appeals in trade-mark cancellations		21
Appeals in ex parte trade-mark cases		47
Interlocutory appeals		19
Total		184
Petitions ex parte	6,703	
Petitions inter partes	141	
		6,844
Total		7,028
Cases disposed of by commissioner:		
Appeals in trade-mark interferences		12
Appeals in trade-mark oppositions		82
Appeals in trade-mark cancellations		20
Appeals in ex parte trade-marks		44
Interlocutory appeals		19
Total		177
Petitions		5,998
Total		6,175
To Court of Customs and Patent Appeals of the District of Columbia:		
Appeals in ex parte cases (including 8 trade-marks)		186
Appeals in interference cases (including 3 trade-marks)		58
Appeals in trade-mark oppositions		29
Appeals in trade-mark cancellations		12
Total		285

OTHER DETAILS OF BUSINESS FOR THE FISCAL YEAR

The volume of business received during the year included 88,707 applications for patents, reissues, and designs; 13,636 trade-mark applications and 1,508 applications for renewal of trade-mark registrations; and 2,866 label and print applications; 227,748 amendments to patent applications, 7,527 amendments to design applications, and 20,079 amendments to trade-mark, label, and print applications.

The number of letters constituting the miscellaneous correspondence received and indexed was 458,601. In addition, 38,076 letters were returned with information.

The number of printed copies of patents sold was 3,959,622; 1,296,454 copies of patents were shipped to foreign governments, and 690,887 copies furnished public libraries. The total number of copies of patents furnished was 6,385,910, including those for office use and other departments.

The office received for record 52,436 deeds of assignments.

The drafting division made 546 drawings for inventors, and corrected 20,127 drawings on request of inventors; 147,548 sheets of drawings were inspected, and 20,824 letters answered.

Typewritten copies of 4,877,800 words were furnished at 10 cents per hundred words. The office certified to 13,890 manuscript copies, and furnished 8,984 miscellaneous certified copies. The office also furnished 363,163 photostat copies of manuscript pages; 57,764 photographic copies, and 466,785 photostat copies of publications and foreign patents, for sale; 9,973 photostat-manuscript pages; 99 certified manuscript copies and 3,549 photostat copies for Government departments, without charge; 18,093 photostat and 13,693 photographic copies for use of the Patent Office; 17,563 photostat copies for sale through photoprint section, and 527 photostats for office use; also 99,302 photostats for assignments, grants, disclaimers, and miscellaneous papers for official use; in all, 978,955 photostat and 71,457 photographic copies.

Very truly yours,

THOMAS E. ROBERTSON,
Commissioner of Patents.

BUREAU OF MINES

DEPARTMENT OF COMMERCE,
BUREAU OF MINES,
Washington, July 1, 1931.

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, 1931.

At the end of each division chapter, short paragraphs give conclusions and recommendations regarding the work of the division; the most pressing future needs are listed among the recommendations.

FINANCES

Total funds available to the Bureau of Mines for the fiscal year ended June 30, 1931, were $3,133,114.19. Of this amount $2,945,357.01 was spent, leaving an unexpended balance of $187,757.18, mainly owing to uncompleted work in the helium program, resulting in the carrying over of $155,000 of helium-plant funds as authorized expenditures for the fiscal year 1932.

On the regular work of the bureau $2,297,781.28 was expended directly, this figure being subject to slight corrections owing 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, $663,544.19 was appropriated directly to the bureau; and $166,000 was transferred from the Navy for the purchase, at cost, of helium produced by the bureau for this military-service branch.

Table 1 presents classified and complete information regarding the financial history of the bureau since its transfer to the Department of Commerce July 1, 1925. A complete statement of the distribution of congressional appropriations to branches and divisions within the bureau and the expenditure of these funds in 1931 by the various divisions of the bureau is given in Table 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. The annual expenditures of the bureau are illustrated in the curves shown in Figure 2.



FIGURE 1.—Annual expenditures of the Bureau of Mines since its organization (exclusive of service items)

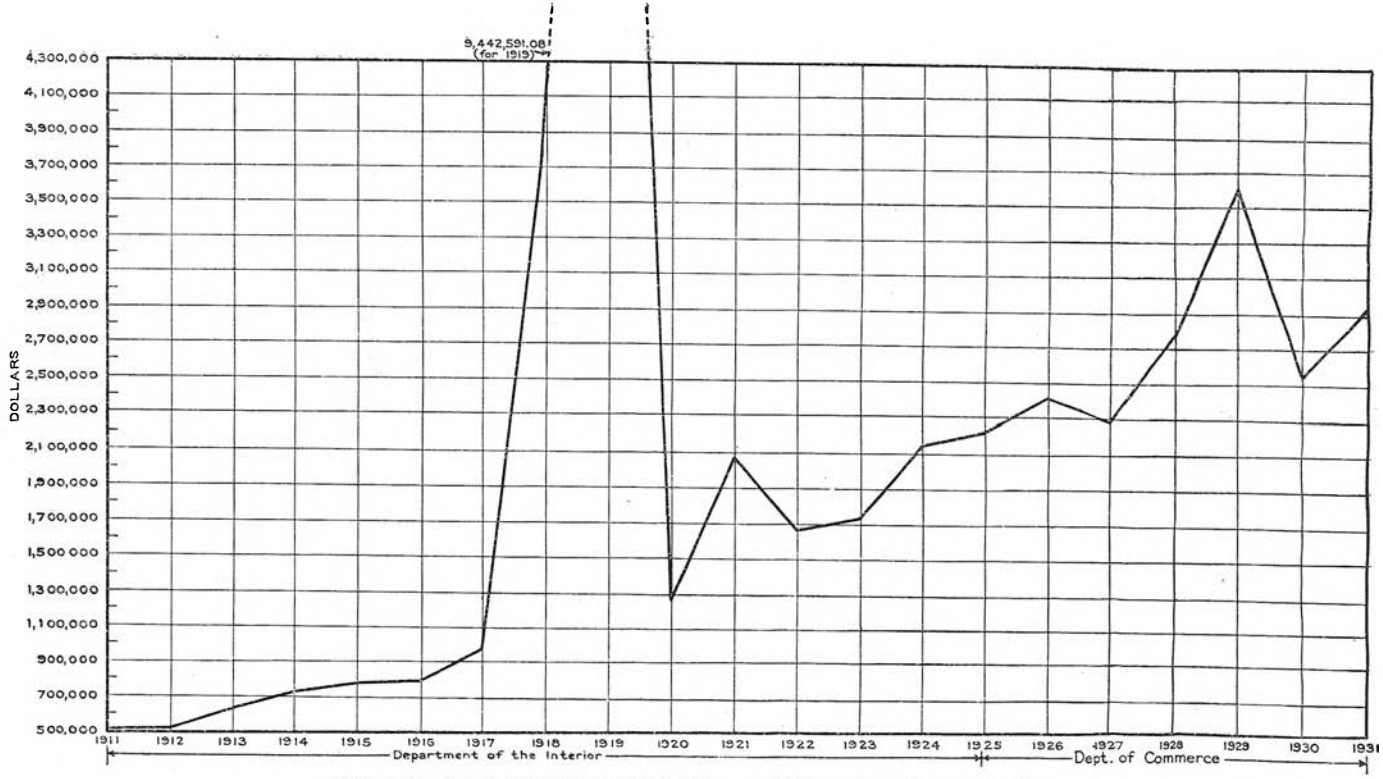


FIGURE 2.—Total expenditures of the Bureau of Mines since its organization

TABLE 1.—*Bureau of Mines appropriations and expenditures, fiscal years ended June 30, 1926–1931*

Fiscal year—	Appropriated to 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]
1926	$1,875,010.00	$81,220.00	$510,501.15	$2,466,731.15	$28,891.78	$2,437,839.37	[3] $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	113,266.45	325,493.46	3,463,909.91	[4] 723,491.71	2,740,418.20	1,997,509.91
1929	3,444,594.67	103,000.00	205,500.00	[5] 3,753,094.67	[6] 126,679.62	3,626,415.05	2,286,010.39
1930	2,394,886.38	123,300.00	166,200.00	[7] 2,684,386.38	[8] 135,145.59	2,549,240.79	[9] 2,217,562.61
1931	2,847,414.19	119,200.00	166,500.00	[10] 3,133,114.19	[11] 187,757.18	2,945,357.01	[12] 2,297,781.28
Total	15,501,455.24	634,429.84	1,699,194.61	17,835,079.69	1,246,837.17	16,588,242.52	12,566,925.11
1932	2,433,765.00	133,550.00	194,500.00	[13] 2,761,815.00			[14] 2,247,045.00

[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] Includes $122,229.39 for mineral resources originally budgeted to Interior Department.
[4] Balance of $719,476.67, helium plants, reappropriated for expenditure in 1929.
[5] Includes balance of $719,476.67, helium plants, reappropriated for expenditure in 1929.
[6] Balance of $120,216.38, helium plants, reappropriated for expenditure in 1930.
[7] Includes balance of $120,216.38, helium plants, reappropriated for expenditure in 1930.
[8] Balance of $102,354.19, helium plants, reappropriated for expenditure in 1931.
[9] Subject to adjustment until June 30, 1932.
[10] Includes balance of $102,354.19, helium plants, reappropriated for expenditure in 1931.
[11] Balance of $155,000, helium plants, reappropriated for expenditure in 1932.
[12] Subject to adjustment until June 30, 1933.
[13] Includes balance of $155,000, helium plants, reappropriated for expenditure in 1932.
[14] Appropriations, allotments, and transfers (exclusive of service items) as of July 1, 1931.

TECHNOLOGIC BRANCH

MECHANICAL DIVISION

Electricity in mines.—In return for permission to mark goods with a plate showing approval of the United States Bureau of Mines, manufacturers of electrical mining equipment submit their product to this bureau to determine whether it complies with certain standards of construction designed to eliminate the more probable causes of gas and dust ignitions. During the past year the bureau classed as permissible 4 loading machines, 7 conveyors, 9 mining machines, 7 mine pumps, 2 rock-dust distributors, 2 junction boxes, 2 storage-battery locomotives, 1 flash lamp, 2 flood lights, and 1 electric cap lamp, all using electric current.

A study of such permissible equipment has been made after it has been put into service in 40 mines in Pennsylvania and 41 mines in West Virginia. The resulting information has been transmitted to manufacturers and improvements have been effected in design that reduce accidents. During the year eight information circulars and two bulletins were published giving the results of investigations on the safe use of electricity in mines.

Removal of ash in molten form from boiler furnaces.—Burning coal in pulverized form has introduced difficult problems in the collection, removal, and disposal of ash. The introduction of a type of furnace in which the deposited ash is tapped as fluid permits the use of coals with ash of low fusion temperature, which previously could not be used in pulverized-coal furnaces. The bureau has continued its cooperation with the American Society of Mechanical Engineers, investigating some of the factors of this method of operation. The relationship between the composition of slag and the temperature at

which it will flow has been established. If the slag will not flow at the temperature of the furnace, a flux must be added; the effectiveness of such materials as are available for use as fluxes has been determined, as well as the relation of the quantity required to the composition of the slag. These problems have a bearing not only on establishing a wider market for certain coals but also on air pollution.

Stoker firing of brickkilns.—The application of stoker firing to brickkilns has been studied in detail during the year, and an investigation has been continued to determine the effect of preheating air on the combustion temperature in the fuel bed and to determine the composition and temperature of gases leaving the fuel bed.

Burning characteristics of domestic fuels.—The burning characteristics of fuels used in domestic furnaces are being investigated; the investigation on coke has been completed.

Fuel-economy service.—The fuel-economy service for Government plants has comprised power-plant studies, fuel-efficiency tests, fuel studies for the proper selection of coal, acceptance tests for new equipment, and consulting service on many problems for the Bureau of the Budget and for various Government power-plant projects, including the purchase of new equipment and the preparation of specifications, all with the object of saving fuel. Typical results follow:

After a study of five Government projects, ways were found to reduce installation expenditures $125,000 and still achieve equal or better results. In a contemplated expenditure of $700,000 it was found that $225,000 would do for the immediate future. Methods were developed whereby 1½ tons of coal a day were saved at one plant. Recommendations were made concerning the most economical fuel and most desirable type of fuel-burning equipment for about 30 different projects, and consulting service was furnished on miscellaneous problems involving fuels in about 20 more projects. In the selection of coal for use in the District various coals offered were tested at about 25 local plants.

Brakes for mine cars.—The mechanization of coal mining has brought need for larger mine cars operated at higher speeds than formerly. To supply necessary information for designing improved braking equipment for such cars the bureau is determining the suitability and relative friction characteristics of various woods for brake blocks. A machine has been constructed that will measure the friction factors and will test the durability of various woods and other suitable brake-block materials. Tests of such materials were continued during the year.

Fuel inspection and coal analysis.—The fuel-inspection section advises Federal departments, and State and municipal governments, if desired, regarding the purchase of coal; it collects and prepares for publication information on the fuel value of coals of the United States. The quality of coal delivered to Federal institutions and certain State institutions is checked; coal is inspected and sampled in the mines, at mine tipples, and sometimes at the point of delivery; and suggestions are issued as to the desirable method of sampling coal. Analyses are sent to the interested parties, with comments and recommendations for settlement. By detection through analysis

TABLE 2.—*Bureau of Mines expenditures, fiscal year 1931*

Branch or division	General expenses	Investigating mine accidents	Mining investigations in Alaska	Operating mine rescue cars and stations	Testing fuel	Mineral mining investigations	Oil, gas, and oil shale investigations	Expenses mining experiment stations	Care, etc., buildings and grounds, Pittsburgh	Maintenance and operation Government fuel yards
Office of the director	$14,023.18									
Office of the assistant to the director	10,195.00									
Administrative branch:										
Office administration division	17,940.79	$8,761.57		$6,252.75	$2,732.66	$2,959.45	$13,397.60	$9,437.56		
Information division	48,422.13	17,852.90		9,419.34	7,167.30	5,820.00		1,894.09		
Total	66,362.92	26,614.47		15,672.09	9,899.96	8,779.45	13,397.60	11,331.65		
Office of chief mining engineer		48,053.43							$1,000.00	
Technologic branch:										
Mechanical division		92,087.97	$11,449.96		150,768.04		8,848.75			
Mining division		29,524.99				78,369.45	2,289.82			
Metallurgical division						72,579.52		129,006.44		
Petroleum and natural gas division							209,341.46			
Experiment stations division		66,641.82		7,598.90	18,632.83	5,189.26		90,925.60	80,114.78	
Helium division										
Explosives division		77,213.65							1,000.00	
Total		265,468.43	11,449.96	7,598.90	169,400.87	156,138.23	220,480.03	219,932.04	81,114.78	
Economics branch:										
Coal division										(1)
Mineral statistics division										
Petroleum economics division										
Rare metals and nonmetals division										
Common metals division										
Office of principal mineralogist										
Total										
Health and safety branch:										
Health division		69,651.04								
Safety division		28,914.78		310,169.01						
Demographical division		2,244.96				140.00				
Total		100,810.78		310,169.01		140.00				
Total appropriations	91,880.00	441,660.00	11,460.00	333,770.00	180,250.00	165,460.00	234,040.00	231,570.00	82,200.00	(1)
Total expenditures	90,581.10	440,947.11	11,449.96	333,440.00	179,300.83	165,057.68	233,877.63	231,263.69	82,114.78	
Unexpended balance	1,298.90	712.89	10.04	330.00	949.17	402.32	162.37	306.31	85.22	

Branch or division	Helium investigation	Investigating potash deposits	Economies of mineral industries	Helium plants	Helium production	Helium plants, 1930–31	Printing and binding	Department contingent	Geological survey transfer	Total
Office of the director										$14,023.18
Office of the assistant to the director										10,195.00
Administrative branch:										
Office administration division	$6,102.50	$4,000.00	$19,645.42	$17,158.64	$7,613.18		$2,124.59	$31,678.61		149,805.32
Information division							5,321.39			95,897.15
Total	6,102.50	4,000.00	19,645.42	17,158.64	7,613.18		7,445.98	31,678.61		245,702.47
Office of chief mining engineer							426.22			49,479.65
Technologic branch:										
Mechanical division							7,018.37			270,173.09
Mining division		95,500.00					1,810.99		$500.00	207,995.25
Metallurgical division							3,088.30			204,674.26
Petroleum and natural gas division	7,274.45						2,668.67			219,284.58
Experiment stations division							8,708.78			277,811.97
Helium division	61,154.59			236,385.55	134,386.82	$177,500.00	119.74			609,546.70
Explosives division							851.43			79,065.08
Total	68,429.04	95,500.00		236,385.55	134,386.82	177,500.00	24,266.28		500.00	1,868,550.93
Economics branch:										
Coal division			62,002.09				843.94			62,846.03
Mineral statistics division			88,767.06				27,366.30			116,133.36
Petroleum economics division			39,783.00				1,897.10			41,680.10
Rare metals and nonmetals division			38,294.65				392.22			38,686.87
Common metals division			30,332.10				325.61			30,657.71
Office of principal mineralogist			5,254.35							5,254.35
Total			264,433.25				30,825.17			295,258.42
Health and safety branch:										
Health division							565.12			70,216.16
Safety division							22,172.06			361,255.85
Demographical division			26,545.00				1,745.39			30,675.35
Total			26,545.00				24,482.57			462,147.36
Total appropriations	75,000.00	100,000.00	311,580.00	408,544.19	166,000.00	180,000.00	87,500.00	31,700.00	500.00	3,133,114.19
Total expenditures	74,531.54	99,500.00	310,623.67	253,544.19	142,000.00	177,500.00	87,446.22	31,678.61	500.00	2,945,357.01
Unexpended balance	468.46	500.00	956.33	[2] 155,000.00	24,000.00	2,500.00	53.78	21.39		187,757.18

[1] Revolving fund.

[2] Reappropriated for expenditure in 1932.

a saving has been made of subcontract coal delivered to the Government. Samples have been taken in Maryland, Pennsylvania, Virginia, and West Virginia, and from 12 cargoes of coal at tidewater piers. The cost of field sampling has been reduced approximately 50 per cent by the development of a sampling truck equipped for mechanical preparation of samples and by other more efficient methods. The truck made possible collection of some samples of anthracite which were needed to answer the numerous inquiries from Federal departments in connection with their coal purchases.

Each year the coal-analysis section analyzes approximately 10,000 samples of coal purchased by Federal, State, or municipal governments or samples collected in connection with bureau-research investigations. Commercial and industrial laboratories desiring to maintain a high standard of accuracy exchange check samples with the Bureau of Mines. The bureau offers this service free.

Gas, coke, and by-products obtainable from coal.—In cooperation with the American Gas Association, a method has been developed for determining (under controlled conditions) the quality and quantity of gas, coke, and by-products obtainable from coal, from both low and high temperature ranges of carbonization. A preliminary report that describes the method (which uses from 80 to 100 pounds of coal) and gives results has been published. When it is assured that the results check with large-scale carbonization it is proposed to make a survey of the typical coals of the United States by this method. So far, 10 different coals from various parts of the country have been examined. Several gas and coke companies have already installed similar apparatus in their research laboratories. As a mechanism for research, the method has many possibilities.

The carbonization of washed and unwashed coal, from one bed, showed that washing improved the physical properties of the coke and the yields of both gas and tar. A study to determine the effect of inerts (such as fusain or mineral charcoal) on coking showed that clean fusain, which floats in coal washing, could be mixed with one type of clean coal and have no deleterious effect on the coke. A comprehensive physical examination was made of tars and light oils obtained at each carbonization temperature. For these studies, a column of solid coal about 1 foot square was cut from the top to the bottom of each coal bed from which samples were taken. A detailed microscopic examination was made of visible components of the coal, and the carbonizing properties of each were determined. During the year much interest has been displayed in classification of coals. The bureau has contributed methods of testing various qualities and studies on chemical relationships in a large range of coals.

Characteristics of coals.—During the year 1929–30, coal samples were taken from every operating mine in the State of Washington. This included seam samples in the mine, as well as samples of the various sizes of coal as shipped. For the first time the bureau applied tests to these coal samples, in a routine manner differing from the former methods of proximate and ultimate analysis, to determine slacking, friability, agglutinating power, and low-temperature carbonization. An apparatus was devised for measuring the plastic properties of coal when heated, and research was continued on the development of methods of determining the temperature at which

coal becomes plastic and the degree of plasticity which it attains. Studies have been made on methods of solvent analysis of coal, and these methods are applied to all coals examined in the survey of gas and coke making properties of American coals. The results have been published.

Synthetic production of organic compounds from coal.—Modern research is pointing out new methods and producing useful organic chemical compounds, such as gasoline, alcohol, acetic acid, etc., directly, or almost directly, from chemical elements; for example, methanol (synthetic wood alcohol) is produced from carbon monoxide and hydrogen, synthetic grain alcohol from ethylene gas and steam, and synthetic gasoline from carbon monoxide and steam. Carbon monoxide, ethylene, and hydrogen in turn may be obtained by carbonization or gasification of coal or from natural gas and steam. The chemistry of these analytical processes is as yet not well understood. Experimental research on the mechanism of these reactions is expected to open new commercial possibilities. The bureau's research in this field is to furnish the theoretical basis for industrial development. Several publications have been issued during the year.

Conclusions.—The development of electrical mining equipment that will promote safety has been greatly aided by the bureau's approval system and is on a much safer plane than it would have been without such aid. A neutral proving ground, where safety is the first requirement, has been acknowledged as helpful to both manufacturers and users.

Recommendations.—Although service work such as the bureau's approval system, its inspection and analysis of fuels, and its fuel-economy work in Government plants yields the most immediate and obvious returns for the money expended, nevertheless more lasting, more far-reaching, and ultimately greater returns may come from well-planned research work. These returns are far less apparent, are rarely immediate, and may seem intangible, but they are none the less real. As appropriations of fixed sums are made year by year the proportion that can be spent for research work continually decreases because of the natural growth of service work to which the bureau has become committed. The future is thus robbed for the sake of immediate gain. This situation is unfortunate. Its first effect is to make us hesitate to undertake further service work, however useful it may be, since the money received from commercial concerns in payment for this bureau's work reverts to the Treasury of the United States and is thus completely lost to the Bureau of Mines, thereby decreasing our funds for research investigations by the sums so represented. When research in any field in the mineral industries can be afforded by the Federal Government, it is believed that increased appropriations for that purpose will be a good investment for the future.

MINING DIVISION

The work of the mining division embraces in particular the detailed study of present-day mining and milling practices as they relate to economy of operation, prevention of waste, protection of

life and property, and the dissemination of knowledge among mine operators and engineers.

As a direct and tangible result of this work, costs have been definitely reduced in some mines; safety has been promoted, especially as regards falls of roof and coal in coal mines; and recommendations with respect to ventilation in a number of metal mines have been followed.

Less tangible, but perhaps of greater aggregate importance in many districts, are the many improvements in details of practice made possible by the fund of information and data on practices in other districts thus supplied to operators. Comparable data, correlated and assembled on many individual operations, provide a yardstick by which each operator may measure the results of his own methods and practices with those of other operators.

During the year 23 publications were issued on ore-mining methods and costs, 21 on ore-milling methods and costs, and 9 on nonmetallic operations, each dealing with an individual property. In addition, seven summaries and one bulletin dealing with special mining problems were published.

Since the inception of the present program circulars have been issued giving operating data and detailed information on companies accounting for, roughly, 70 per cent of the annual output of copper in the United States, 60 per cent of the lead and zinc production, 30 per cent of the iron production, and smaller percentages of other metals. Twenty additional papers are now in press.

Geophysical methods of prospecting.—The geophysical section undertook a study to determine, if possible, to what extent the various methods of geophysical exploration would warrant field application in various mineral and oil districts. Special emphasis was placed on deposits of chromium, nickel, and iron. Results of these investigations show that the examined nickel and iron deposits are easily amenable to these methods of exploration, both for reconnaissance and for detailing the ore deposits, whereas chromium deposits deserve further study.

The application of electrical methods developed by the bureau indicate that oil pools in Kentucky have their own peculiar geophysical characteristics. Intelligent observations and application of ground measurements will eliminate the drilling of many dry holes.

Laboratory work was applied to the technique of measuring small angles with precision. This will form the foundation for the construction of gravity variometers used for delineating oil structures.

To make available the latest domestic as well as foreign published contributions to this new branch of science an abstract journal has been issued monthly.

Cooperative work with the Canadian Geological Survey, the mining department of Harvard University, and the General Crushed Stone Co. has helped to extend the scope of this study.

In the past year, 3 technical papers, 13 information circulars, and 1 technical translation were issued.

Mining and preparation of nonmetallics.—The nonmetallic section has continued its study of mining methods as applied to the nonmetallic industries. During the year 9 reports of individual operations were published, covering mining methods used at 2 fluorspar

mines, quarrying and crushing of stone at 3 cement-plant quarries and at 1 crushed-stone plant producing trap rock, dredging and treatment methods at 2 sand and gravel plants, and the milling of feldspar at 1 plant. In addition to these, 7 other papers have been prepared for publication, and 94 others are in various stages of preparation through the cooperation of the industry. The reports written by the operators record in technical detail the methods used in mining and preparation, and give operating costs tabulated as to operating steps. Costs are in dollars and cents as well as in units of labor, power, and supplies. Reports, published and in progress, cover the geographical area of the United States from Maine to California, representing 27 States and Alaska.

The study of methods of mining is especially useful at this time to disseminate technical information among operators whereby they may analyze their own results, compare them with others, and by adopting more efficient practices lower operating costs and lessen wastage.

Mining methods, Central and Eastern States.—Most of the year was devoted to the study of special mining problems and gathering data thereon. Circulars were published on the following special subjects: Shrinkage Stoping, Mining by the Top-Slicing Method with Some Notes on Sublevel Caving, Underground Transportation, and A New Signaling Device for Shaft Mines. In the first two circulars mining methods were discussed from the standpoint of their productive importance, their applicability to type conditions, their advantages and disadvantages, variations in practice to suit special conditions, and also as to cost analyses. The studies of this section have revealed that methods unsuited to the conditions have sometimes been employed; a more thorough understanding of the principles involved, and the economics of the different methods, should go far toward eliminating such mistakes in future.

A special study was made of the sampling and estimation of ore deposits, and a manuscript on this subject is ready for publication as a bulletin. During the year, circulars were issued dealing with five iron-mining operations and one copper-pyrite mine.

Contacts were made with important mining interests in Canada, whereby four papers were prepared for publication (now in press), and the assurance obtained of others to follow soon. Studies of problems peculiar to mining at great depths were initiated, and progress has been made in the work.

Mining methods, Western States.—Reports dealing with mining practices at individual mines were published during the year; 16 such circulars were issued. Four dealt with copper mines, 2 with gold, 1 with an iron mine, 1 with lead-silver, 1 with silver, and 7 with mines producing complex ores containing lead, zinc, copper, silver, and gold. Seven similar papers were completed and are now in press, and 11 others are in various stages of preparation.

Much attention was devoted to the study of special mining problems. The operating data and other information in the circulars on individual mines have been correlated and, supplemented by special field study of each problem under consideration, are serving as a basis for the preparation of articles dealing therewith. One such article, Shaft-Sinking Practices and Costs, has been completed

and is ready for publication as a bulletin. Papers on special problems as follows are nearly completed: Square-Set Method of Mining, Cut-and-Fill Mining, and Methods and Estimated Costs of Mining Shale.

Milling methods and costs.—During the past year an investigation of milling practices and costs at the principal metal mines of the United States and at certain mines in Canada and Mexico was given much attention. As a basis for the study of special problems in milling, a number of papers on individual plants have been written by the superintendents and engineers in charge. These papers describe the characteristics of the ore treated; tonnage handled by each machine; and operating details of each step in the process, such as crushing, screening, grinding, classifying, conveying, sampling, and gravity and flotation concentrating. Following a description of the material treated and the methods of treatment employed, in each instance are given the percentage recovery of valuable mineral, the cost of making this recovery for the entire operation and for each stage of the process, and the consumption of supplies, labor, power, and reagents per ton milled. During the year, 21 such papers were published; 9 of these deal with copper ores, 2 with lead-silver, 3 with lead-zinc-silver, 3 with zinc-lead, 1 with a mercury ore, and 3 with gold ores. Eleven others are completed and ready for publication, and several more are in various stages of preparation.

Subsidence and ground movement.—During the year investigation was continued of conditions of occurrence of ores and associated formations, and their relation to failure of ground in open-cut and underground operations. Field work was carried on in Idaho, Colorado, Wyoming, Utah, Nevada, Arizona, Nebraska, and New Mexico. Much fundamental information was collected upon which to base suggestions for precautionary measures to prevent uncontrolled collapse of mine workings and surface subsidence which might threaten the safety of life and property. The preparation of material for a bulletin dealing with subsidence and ground movement in the copper mines of the West, based on studies during the past two years, is nearly completed. A paper dealing with the essentials of subsidence and ground movement was completed for publication.

Methods and costs of mine ventilation.—The general program of surveys of methods and costs of ventilating metal mines was continued during the year. Reports were made to operators regarding possible improvements in underground air conditions and as to methods of solving particular difficulties. In several instances recommended changes were put into effect, with pronounced improvement in air conditions at these mines.

Surveys were made of a group of six mines in the Michigan copper district and of separate mines in South Dakota, Utah, and Nevada. The results of similar previous surveys in Arizona copper mines were published as Bulletin 330, and in the Coeur d'Alene mining district as Information Circular 6382. As a further result of the surveys to date a general bulletin is being prepared, in which the practical application to metal-mine ventilation of experimental data gathered by the bureau and from other sources will be stressed.

Falls of roof in coal mines.—Falls of roof and coal are responsible for the death of more than 1,000 miners annually and, in coal mines, account for practically 50 per cent of the total fatalities resulting

from all causes. Investigations of this subject were continued, both in Eastern and Western States.

In the East work was concentrated at mines in western Pennsylvania and northern West Virginia. Reports of investigations were issued on mines in eastern Ohio, as a result of earlier studies, and on mines in the Greensburg-Latrobe Basins of Pennsylvania and of Harrison County, W. Va. Similar reports on mines in Marion and Monongahela Counties, Pa., and the Panhandle of West Virginia are in final state of preparation for publication; three others, covering mines in the Pittsburgh field, are being prepared. Confidential reports, with recommendations relating to practices for prevention of injury from falls of roof and coal, have been issued to 12 mines in Pennsylvania and West Virginia.

In the West investigations were made in Utah and Wyoming. Cooperative arrangements were established with operators and the State mine inspector and Industrial Commission of Utah, under which much progress was made in the advancement of safe mining practices there. In Wyoming the work of the bureau engineers has been recognized as playing a prominent part in the adoption by large operators of systematic timbering in the mines, with attendant reduction of mining hazards. Thirteen confidential reports, with recommendations relating to practices for prevention of injury from falls, were issued to the operators.

Search for domestic potash supplies.—The 5-year program of potash exploration authorized by act of Congress of June 25, 1926, will end with the completion of the contract for drilling holes No. 21 to No. 24, inclusive.

Since June, 1930, the drilling of holes 18, 19, 20, 22, and 23 has been completed. These drill holes were situated as follows: No. 18, in Loving County, Tex.; No. 19, in Lea County, N. Mex.; No. 20, in Lea County, N. Mex.; No. 22, in Eddy County, N. Mex.; and No. 23, in Eddy County, N. Mex. Hole 21 is now being drilled in Lea County, N. Mex., and within a short time operations at drill hole 24, in Grand County, Utah, will be commenced.

Of the $100,000 appropriated for this purpose for 1931, $12,500 was transferred to the Geological Survey to defray expenses of field and laboratory work in connection with selection of drilling sites and examination and analysis of core samples; and $12,251.80 was expended by the Bureau of Mines for salary and field expenses of the bureau engineer in full-time charge of drilling operations and for procuring a carload of polyhalite for shipment to the bureau's laboratory at New Brunswick, N. J. This left $75,248.20 for actual drilling. The total drilling completed during the year was 8,817 feet 10 inches, at a cost of $69,187.57, or an average of $7.84 per foot.

The principal potash mineral encountered in the drilling is polyhalite, a sulphate of potash, magnesia, and lime. Pure polyhalite contains potassium equivalent to 15.6 per cent of K_2O. Polyhalite beds of possible commercial interest were found in holes 3, 6, 13, 14, 17, and 18. Important showings of carnallite ($KMgCl_3.6H_2O$) and sylvite (KCl) were found in No. 17 and No. 18. Langbeinite ($K_2SO_4.2MgSO_4$) was also found in No. 17 hole.

During the year Bulletin 327, Potash Bibliography to 1928 (Annotated), was published.

Conclusions.—The work of the mining division has resulted in improvement in mining and milling practices, provided greater knowledge of the applicability of certain geophysical prospecting methods, and increased understanding of the principles of ventilation, ground movement, and other subjects pertinent to the technology of mineral exploitation. Safety and economy of operation have been enhanced in measurable degree. More detailed information on mining and milling methods and costs at most of the important operations in the United States is now available than ever before, as a result of the activities of the mining division. This has proved not only of distinct value to the mineral industry as a whole but of real assistance in technical education as well. The work to date indicates the need of further investigation along special lines and has provided a groundwork for more advanced studies which could have been supplied in no other way.

Among the problems upon which work was started late in the year are: Gold dredging and hydraulic mining, mine accounting and office management for medium-size mines, and methods and costs of gold mining.

Government drilling has demonstrated the wide distribution of potash minerals in the salt beds of the Permian Basin, since potash was found in every hole drilled. While the holes are too far apart to give evidence of the lateral extent of any one deposit, the occurrence of beds of mineable thickness sufficiently rich to be of possible commercial interest has been proved. Several areas favorable for commercial development have been indicated; others less favorable were found, which may be eliminated from consideration and regarded as unpromising areas for prospecting.

Recommendations.—During the coming year it is hoped that the mining division may be given sufficient financial support to complete its studies of individual operations, to undertake additional studies of this kind which may be warranted by features of unusual interest, and to proceed with the program of investigations of special mining, milling, and geophysical problems. As far as is possible with the limited funds available much attention should be given those problems most amenable to improved technique or reduced operating costs and to certain features with regard to which published information is lacking or incomplete. It is proposed also to keep in touch with and report on the latest improvements in practices, methods, and equipment as they are installed at individual mines and plants. Adequate funds for this important and necessary service to the mining industry have not yet been provided; the amount of money annually available for work of this nature should be more than doubled.

The results of the 5-year potash-drilling program are believed to be sufficiently indicative of possibilities for commercial development to point the way for private enterprise. This objective having been reached, continuation of exploration by the Government is not recommended.

METALLURGICAL DIVISION

The metallurgical division not only proposes to make fundamental studies of metallurgical processes that will open new avenues of development, but also, in certain selected instances, to carry out the

development of these processes to the point of demonstrating their practicability.

This year the metallurgy of zinc was selected for such development. A careful study of zinc smelting was made at the Pacific Experiment Station and reported in Bulletin 324, Zinc Smelting from a Chemical and Thermodynamic Standpoint. Based on the data accumulated in that study, a process for the reduction of zinc oxide by methane or natural gas has been devised. After a thorough study, described in Report of Investigations 3091, The Reduction of Zinc Oxide by Methane, the process has been tried on a semiplant scale; it now gives promise of commercial success. In view of the large supply and low price of natural gas, and of the high-purity product which the new process is capable of producing, regions having both commodities available, such as the Tri-State district, should find the process a great economic asset, if it can be brought to commercial operation. The bureau is continuing its work toward solving the engineering problems incident to commercial operation of this process.

NONFERROUS METALLURGY

Thermodynamic data for metallurgical problems.—Possibly the quickest way to determine the merit of a new process which economic and technological changes have indicated as feasible is to study the heat requirements by calculations based upon thermodynamic data.

During the past year, from many sources, the Bureau of Mines has collected data and made them available under one cover in a publication now in press. Nearly all of the substances have been listed that are of importance in ferrous and nonferrous metallurgy so computations may now be made with a knowledge of the reliance that can be placed upon their accuracy.

The data shown by this critical study to be missing, or to be of insufficient accuracy, are now being supplied as rapidly as possible by direct experimentation. During the year, at its Pacific Experiment Station, the bureau determined low-temperature specific heats of vanadium trioxide, vanadium tetroxide, lead sulphide (natural and synthetic), cuprous sulphide, cupric sulphide, manganous sulphide, ferrous sulphide, and calcium sulphide. High-temperature specific heats of cuprous oxide and tungsten were measured.

Valuable as thermodynamic data are in indicating what can be accomplished by given reactants, the data themselves furnish only a rough idea as to whether the given reaction will proceed with enough speed to be applied commercially. In order to tell the complete story it therefore is necessary to obtain further data upon rates of reactions and to learn the mechanisms and steps by which reactions proceed. This information has been obtained for certain reactions, notably zinc and methane, copper minerals and leaching reagents, and others.

Treatment of copper ores.—The rate of solution of the various copper minerals—a study of speeds of reaction—is one of the determinants of the success of a commercial process for leaching copper. Sulphuric acid and ferric sulphate are the two most important commercial solvents, and the speeds have been determined at which they will dissolve all of the principal copper minerals. Data on the effect

of size of particle and of temperature have also been made available and have even been applied in one copper refinery where the metallurgists found they could leach profitably some of their copper that had been oxidized in fire refining.

The low selling price of copper and the physical nature in which minerals of copper are now present in many low-grade products have necessitated the development of cheaper processes for the extraction of certain copper minerals. A method has been developed that increases the permissible amount of slime that may be present in an ore without making it less amenable to leaching by percolation. This should enable some operators to avoid the expense of the separation and separate treatment of sand and slime, where a leaching process is desired for both.

Leaching gold and silver.—The proper preparation of a charge to handle an added amount of slime by percolation can also be utilized where the ore contains gold, silver, or other metals. In connection with the cyaniding of gold, chemical matters must be considered in addition to these mechanical ones.

Studies have been made of the regeneration of cyanide, combined with various amounts of base metals that had been dissolved from gold ores. A process that makes possible the recovery of much of the cyanide from such combinations was developed. The bureau has also worked on the problem of premature precipitation of gold from liquors in leaching ores containing graphite. Flotation has also been used either to remove the consumers of cyanide and precipitants of gold or to make products that may be treated successfully by leaching or smelting. Recently a concentrate of excellent grade has been made from ore from one of the most widely known gold-producing districts of America.

Smelting of copper and lead.—The presence of magnetite in copper slags has long been known to be associated with the loss of copper. The occurrence of this substance in the reverberatory furnace has also reduced the length of furnace campaigns. A study of the reduction of this substance with the materials at the disposal of the smelter metallurgist and the temperatures needed for the reactions to proceed rapidly has been finished and the final reports made available. During the year publications were also issued on the flotation of copper from converter slag, describing a method which will enable the metallurgist to control the balance of iron and silicon in smelting more effectively.

The flotation process has made it possible to treat lower-grade lead ores more cheaply and has therefore increased the practical ore reserves of the Nation. Shipping to the smelter of rich, finely divided, fusible material has necessitated improvements in smelter practice. During the past year the bureau has studied in detail how one smelter is treating successfully an exceedingly rich charge. This smelter has found it possible to increase greatly the production of bullion from its blast furnaces, over that from smelters handling lower-grade charges. The developments in technique that have made possible this change, and the radically different chemistry of operation, have been studied in detail by the metallurgists of the bureau and have been made available in a series of publications.

Developments in laboratory technique.—In the study of its problems the bureau utilizes various tools and techniques, many of which

must be developed for each specific problem. Thus, during the past year, in the study of finely disseminated ores, for which the microscope has furnished data otherwise unobtainable, methods have been developed for rapid identification of various lead-silver minerals, some of which are of uncommon occurrence. New calorimeters have been devised for thermodynamic studies. Apparatus has been designed for the study of smelting both lead and copper ores. The X ray is being used in studies of the physical properties of minerals.

FERROUS METALLURGY

The fiscal year 1930–31 has marked the completion of the 5-year program of research on the physical chemistry of steel making conducted at the Pittsburgh Experiment Station in cooperation with the Carnegie Institute and the steel industry as represented by a metallurgical advisory board.

This study has resulted in important additions to our knowledge of the mechanics of open-hearth reactions, particularly with regard to deoxidation, and the contact brought about by this work between the steel makers and the research engineers of the bureau has been of great value to both.

As a tangible result of this work, a new alloy for the deoxidation of steel has been developed. This alloy contains manganese, silicon, and iron, and is well adapted to manufacture from domestic manganese ores. Its development is therefore a contribution toward the solution of the domestic manganese problem, as well as the problem of increased freedom of steel from inclusion. This alloy has been used by steel plants under the supervision of bureau engineers, and its advantages have been made sufficiently evident to the industry so that further application will be made directly by industrial organizations.

It has been shown that acid open-hearth steels relatively free from oxide inclusions may be made by the addition of ferromanganese to the furnace just before the heat is tapped. At this time, nearly all acid steels contain 0.03 to 0.06 per cent of SiO_2, which combines with the MnO to form a fusible manganese silicate which rises out of the steel bath. The mechanism of this process is exactly the same as that using the manganese-silicon alloys described above. The only difference is that no addition of silicon is required, as the steel already contains enough silica for the fluxing process. Steels made by this method in the acid furnace are fully as free from inclusions as those made by the basic method and deoxidized with manganese-silicon alloys.

A large portion of the system $MnO\text{-}SiO_2\text{-}Al_2O_3$ has been investigated for the purpose of finding a slag composition that has a lower melting point than the $MnO\text{-}SiO_2$ slags which are formed upon oxidation with manganese-silicon alloys. These latter binary slags melt at approximately 1,200 to 1,300° C., some 200 to 300° C. below the melting point of pure iron. The work on the ternary slags, however, indicates that fusible materials can be found which melt at approximately 800 to 900° C., some 600 to 700° below the melting point of iron. If such materials can be formed in liquid steel by the addition of an alloy of iron, manganese, silicon, and aluminum, a much more rapid deoxidation and inclusion elimination will result than can be

obtained with the manganese-silicon alloy (high-silicon spiegel) alone.

Method of determining nonmetallic inclusions in steel.—The Bureau of Mines has developed an electrolytic method for the analytical determination of the nonmetallic inclusions in steel. This is rapidly being accepted as a standard procedure for MnO-MnS-FeS, SiO_2, and Al_2O_3 (when the Al_2O_3 content is low). A procedure for the extraction of FeO is now being evolved.

Production of ferromanganese from manganiferous iron ores.—The program for the production of ferromanganese from the manganiferous iron ores of Minnesota has just been completed. From an ore containing 8 per cent of manganese a manganiferous pig iron was made. This was treated in the open hearth to yield a high-manganese slag, from which, in a test just concluded, ferromanganese has been made in the blast furnace. Thus an 80 per cent manganese product has resulted from the treatment of an 8 per cent ore.

Transfer of heat from moving gas stream to column of irregular solids.—The coefficients of heat transfer from moving gas to various solids have been determined under many different conditions. The character of the surface and the shape of the particle are apparently the principal factors in fixing the figures. In general, the over-all coefficient of heat transfer varies directly as the 0.7 power of the gas velocity, as the 0.3 power of the absolute temperature, and inversely as the 0.9 power of the particle diameter. The logarithm of the coefficient varies as a parabolic function of the voids in the bed.

ORE DRESSING

Improvements in milling practice of Tri-State zinc district.—Four practical developments have been made by the Bureau of Mines in the treatment of Tri-State zinc ores: (1) The constituents of mill water adversely affecting flotation have been identified; their removal has improved flotation. (2) A method developed by the bureau for the treatment of dolomitic flint tailings prior to jigging gives promise of lowering the grade of the tailings. (3) The use of dichromate, as a conditioning agent in the reflotation of zinc concentrates from tailing mills, has raised the final grade of the product. (4) Difficulties encountered in flotation when lime had been used in the thickeners were overcome by the development of a new feeder.

Beneficiation of manganese ores.—Three years of work on the beneficiation of manganese ores have just been completed. The bureau has tested the amenability of many domestic ores to various methods of concentration. Reagent combinations, suitable for the flotation of carbonates and certain oxides, were developed, and gravity methods were adapted to certain other ores. Pilot plants and commercial mills have been erected and operated as a result of these investigations.

Laboratory investigation of ball milling.—A study of the power requirements in a mill of commercial proportions (24 by 24 inch) has solved problems in ball-mill mechanics that had heretofore been confounded by indeterminate slippage within the mill. These power studies showed that the quantity of balls, the amount and size of ore, and the amount of water could be varied to control the slippage.

They also showed that the maximum power was consumed when the mill contained only about half enough pulp to overflow the 5-inch discharge opening. Because maximum grinding generally accompanies maximum power the discharge opening was increased to 18 inches. The mill could then retain only half the former pulp charge, and the grinding was found to be increased as was predicted. Closed-circuit grinding tests have substantiated the power-study conclusions; they have emphasized the necessity for thorough removal from the circuit of finished material and have demonstrated the effectiveness of balls smaller than those generally used in practice. In connection with the removal of finished material from the grinding circuit, a new machine, the sizing jig, has been developed.

Study of minus 300-mesh mill products.—In a study of material finer than a 400-mesh sieve, divided into various size fractions by ascending currents of water, the Mississippi Valley Experiment Station has found that the lowest recovery of lead is made from the finest sizes. This holds true down to the ninth theoretical sieve below 400 mesh. A similar study in Utah showed that the grade of concentrate from a chalcopyrite-pyrrhotite-pyrite ore decreased rapidly below 150 mesh. These results point to the desirability of avoiding excessively fine grinding.

Beneficiation of complex sulphide ore from a Southwestern State.—The present method for differential flotation of a complex sulphide ore from the Southwest has been improved. The new method is an improvement on commercial practice, and results indicate reagent costs are about 5 cents a ton less than at present.

Concentration of Lake Superior iron ores.—A comprehensive series of tests has shown that the adoption of more advanced milling methods will materially increase the recovery of iron in the Mesabi washing plants. Adoption of the suggested flow sheet will also permit reclaiming a large tonnage of concentrates from material discarded in the past. One large operator is now planning to utilize these suggestions.

Soap flotation of nonsulphide ores.—Since reporting that the flotation of fluorspar and rhodochrosite, worked out at the Mississippi Valley Experiment Station, has been commercialized, the bureau has extended its list of nonsulphide ores concentrated by soap flotation; barite, siderite, scheelite and ferberite, chromite, cyanite, beryl, pyrolusite and psilomelane, and spodumene have yielded concentrates. The results with many of these ores seem as promising as did those with fluorspar and rhodochrosite before that work was carried to commercial success.

Effect of gases in flotation.—In a study at Salt Lake of the effect of various gases in flotation it was found that the floatability of sphalerite, after the mineral had been subjected to the action of H_2S before flotation, was increased to a remarkable degree. This effect was not produced in the experiments with galena, pyrite, chalcopyrite, or pyrrhotite; with these minerals H_2S is practically inert, although galena containing fine particles is depressed by the H_2S treatment.

CONCLUSIONS

Many results of the research conducted by the metallurgical division during the year have already been applied commercially, at

least on a pilot-plant scale, and have indicated economic success. A new deoxidizer for steel that has resulted from research at the Pittsburgh Experiment Station has been used commercially by a number of steel plants. Suggested improvements in the milling of zinc ores in the Tri-State district have been adopted rapidly. Several concerns have been interested in the new reagent combinations for flotation of manganese carbonate and certain manganese oxides. Flow sheets suggested for use in mills to concentrate Lake Superior iron ores are now being adopted. The reduction of zinc oxide by natural gas, although not in as advanced a stage, nevertheless has attracted considerable commercial attention, and the future experiments are being watched with interest by zinc producers.

It is too soon to evaluate the economic importance of the more fundamental studies. The commercial adoption of such results is always slower than that of processes. However, just as the thermodynamic study of zinc eventually led to the development of the present promising zinc-smelting process, so the work of the past year on the fundamentals of various other metal sulphides and oxides may eventually lead to similar process developments either by this bureau or by others. The studies of the relation between various operating variables in ball milling and the results obtained will certainly find industrial application. For example, maximum grinding was found to occur with a larger discharge opening than that customarily used. The increased effectiveness of smaller balls than are used in practice was also shown. Many nonsulphide ores were floated through the use of soap. This process, first applied to manganese carbonate and fluorspar, has been applied commercially in both instances. There is no reason why further extension of this work should not be of as great interest and use.

RECOMMENDATIONS

To make available the results of its comprehensive investigations of manganese the metallurgical division plans to publish within the next year an exhaustive monograph on manganese. It is hoped that this may be followed by similar publications on lead, copper, and other metals on which the bureau has conducted intensive research. Additional study should be directed to supplying information that has not been obtained in the work already conducted and that is not otherwise available.

The experimental work of the division during 1932 will be directed to (1) a thorough study of the effect on smelting methods and steel practice and the products obtained therefrom of the beneficiation of iron ore to an exceptionally high degree, and (2) the completion of the studies of zinc reduction by natural gas. In the former project the stations at Minneapolis, Pittsburgh, and Rolla will participate; the western stations will concentrate on the second. Concerted action of the two groups of stations on two major investigations should produce significant results. Work on such important projects, with many phases demanding attention, is susceptible of expansion in many useful directions; it is recommended that such expansion be made possible whenever the financial position of the Federal Government renders this feasible.

PETROLEUM AND NATURAL-GAS DIVISION

During the year the natural-gas industry has expanded, extending its markets to industrial centers and bringing gas into competition with other fuels. Concurrently, the petroleum industry experienced drastic economic adjustments, brought about by intensive development of prolific fields and resulting overproduction of crude oil. These natural-gas and petroleum matters are economic only in part; the engineering phases have a real and definite bearing on the problems, both as contributing factors and as stabilizing influences.

Flow of gas in pipe lines.—Pipe-line design, and the measurement of gas flow through lines, has a highly important economic bearing on natural-gas distribution. About four years ago the problem of pipe-line flow was undertaken by the bureau in cooperation with the natural-gas department of the American Gas Association. The main objective was to determine pipe-line-flow formulas that would be sufficiently accurate, yet not too highly theoretical or involved, to complicate their usefulness. A number of investigators hold that the Reynolds criterion is the true measure of friction. The results of tests of 30 operating pipe lines disclose a relationship between the coefficient of friction and the variables of the Reynolds criterion, but when applied to the limited range of conditions in present-day natural-gas-transmission practice the effect is minor. Such factors as roughness of the interior walls, presence of condensates or dirt, differences in elevation at the ends of the line, and flexibility of operation owing to the fact that natural gas is a compressible fluid are more important ultimately in the design of a pipe-line system than obtaining an accurate criterion for the coefficient of friction within the line.

The conclusions, based on representative pipe-line tests throughout the United States, are that the Weymouth flow formula is sufficiently accurate for purposes of design and operation, and is the most practical for all ranges of size and condition of commercial pipe lines. This study has shown further the advantages of maintaining clean pipes and the economic benefits of keeping the pressure drop at the minimum.

Representative groups in the natural-gas industry have unanimously indorsed that report of the bureau which includes full discussion of the Weymouth flow formula, the application of the Reynolds criterion, and those factors in pipe-line construction and utilization that affect efficient design and operation. The natural-gas industry now has a definite guide for the design of its transmission lines. The importance of this contribution is realized better when it is known that conservative estimates place the value of the expansion of the natural-gas industry during the last year at $500,000,000; that 1,000-mile transmission lines have become a reality; and that some of these lines may deliver maximum peak loads of or exceeding 250,000,000 cubic feet per day.

Estimating gas reserves.—In a study of the compressibility and viscosity of natural gas, determinations of 15 representative samples show the deviation from Boyles's law, using pressures as high as 1,000 pounds per square inch. It was found that the deviation is a function of the chemical composition of the gas; gases containing

higher hydrocarbons deviate more than those having a high percentage of methane.

The results obtained bear directly on estimating gas reserves by the pressure-drop method, wherein it has been common practice to disregard deviations from Boyles's law. A new formula has been developed in which deviation is a factor. Use of this formula gives evidence that under some common conditions in natural-gas fields, when the supercompressibility of the gas is neglected, the amount of calculated reserve is higher than the actual amount of gas remaining in the structure. The discrepancy lies in the fact that the amount of void space in the sand is calculated from the amount of gas that has been withdrawn and is measured at a pressure less than the reservoir pressure. The uncertainties of calculation by the pressure-drop method, owing to water encroachment and to possible errors in pressure and production records, are recognized; however, if further work in the field substantiates the mathematical and laboratory results, an important contribution will have been made to the science of estimating gas reserves.

Controlling and gaging natural-gas wells.—When a fundamental basis was first proposed by the bureau for controlling and gaging natural-gas wells to determine the open-flow capacities of the wells without blowing gas to the atmosphere, many gas-company engineers had no clear conception of the data necessary, and some questioned the authenticity of the results. However, in a recent open discussion of this problem natural-gas engineers of nationally recognized standing stated that the principles of gaging gas-well capacities as formulated by the bureau are working out satisfactorily in the majority of wells. Not only have these studies given the natural-gas industry a proved method of gaging gas-well capacities, but knowledge of back-pressure relations has had other successful applications. Among these are: (1) Forecasting drilling requirements, (2) determining the presence of cavings in wells, (3) designing gathering systems, (4) determining operating pressures, (5) estimating costs of production, and (6) judging the advisability of storing gas in sands.

Flow of gas, oil, and oil-gas mixtures through porous media.—To determine a well's ability to deliver gas, knowledge of the character of flow of gas through the sand to the well is essential. Tests have been made in which air was passed through a fixed volume of resistance material, and the rates of flow were observed over a range of pressure drops which ranged from approximately 100 pounds to 0.25 pound per square inch. Known quantities each of oil and water were injected into the void spaces of the material, and the effect on the character of the flow was observed. So far, the tests show that the presence of a liquid in the material influences only the coefficient in the equation for flow, and that the value of the change is proportional to the degree to which the voids of the material are filled by the liquid. Flow relations now are being studied at working pressures of 500 to 1,500 pounds per square inch over a wide range of sizes of resistance materials.

Oil-recovery curves obtained from laboratory experiments and orifice-flow curves obtained in the natural-gas work are almost identical in type. This similarity is important because it indicates that the flow of air and gas through sands is in effect through a series

of orifices, and not through a group of capillary tubes as has been suggested by some investigators.

With the establishment of fairly definite relationships regarding the flow of gas, oil, and oil-gas mixtures through sands, a large fund of data will have been gathered also on the problems of well spacing, estimating gas reserves, gas injection, and migration. Correlating field studies, with reference to gas storage and migration of gas through reservoir sands, were made in California and the Appalachian region.

Oil recovery.—The need for information on the fundamental principles and relationships involved in the various methods of increasing the recovery of oil from depleted fields is indicated by the continued interest in this phase of the bureau's work, regardless of present overproduction in the petroleum industry. It is recognized that no method of production which leaves large quantities of oil underground is economically sound or compatible with true conservation. The gas drive at present has the widest application of the several methods used to stimulate production. The bureau's study of the gas drive showed that: (1) Density of a pressure medium affects oil recovery because of the greater kinetic energy available in a denser medium; (2) control of the injection rate is advantageous because gas-oil ratios and energy expended may be reduced; and (3) solubility of a pressure medium reduces the viscosity and surface tension of the oil and also increases the volume of the oil, thereby increasing the saturation of the sand which tends to reduce gas slippage.

Solubility of gas in oil.—Based largely on experimental work with relatively dry gas and crude oils which had lost many of the lighter hydrocarbons, the general concept has been that solubility of natural gas in crude oil increases in direct proportion to the pressure at which gas is put into solution. Recently the bureau obtained solubility data on well-head samples of oil-gas mixtures from high-pressure wells in the Oklahoma City, Kettleman Hills, and Ventura Avenue fields. Preliminary tests show that when gas is released from these oil-gas mixtures more gas is obtained than would be expected from a straight-line pressure-volume relationship. This finding is important in all production problems.

Another factor brought out by this study is the large percentage of shrinkage of a crude oil upon giving up its naturally absorbed gas. This may mean that when ultimate production of natural reservoirs is computed a shrinkage factor should be applied in addition to the depletion that can be measured in actual barrels of oil produced. The taking of oil-gas samples at the bottom of wells, together with measurements of the temperatures and pressures in the wells is the next step in solving this problem. A recording temperature and pressure instrument has been constructed and is being successfully operated.

Chemistry and refining of petroleum.—Centralized study of several problems dealing with the composition of crude oil and its products and with fractionating and treating methods gave data which, when applied to refinery operations, appreciably reduced the cost of manufacturing valuable products from crude oils relatively high in deleterious substances. Sulphur and sulphur compounds

are the most detrimental constituents in crude petroleum or petroleum products.

The bureau's study has shown that the percentage of sulphur in a crude oil does not necessarily give an indication of the ease or difficulty of refining the light products from that oil. The determining factors are the form in which the sulphur is present and the methods used in obtaining the light products. It was found, also, that the objectionable constituents seem to predominate in some fractions of the parent materials more than in others.

An experimental bubble tower was used, which permitted close observation of conditions within the tower. A detailed study was made of the results of fractionating pressure distillates and of dividing the gasoline into two or more fractions. From a comparison of the experimental data with plant operation it was possible to point out the value of a good degree of separation of the products, especially in the high ends of the gasoline stream, to decrease the amount of chemical treatment. The diverse properties of different crude oils make it impracticable to formulate any one method that is suitable in detail for refining them. It is now generally recognized, however, that many oils, which heretofore were considered unsuitable for the manufacture of motor fuels and lubricants, are good refining stock if efficient fractionating methods are used.

Application of the principles of proper fractionation has been made in a specific study of West Texas crude oils for the purpose of isolating and identifying the various types of contained sulphur compounds. A survey of the so-called black oils of the Rocky Mountains was made, and the samples were analyzed with special reference to the sulphur determinations. Work on the sulphur compounds in shale oils, and the cracking of these oils, has shown a close relation to the study of black oils. A study of the effect of fractionation under vacuum on the removal of asphalt and sulphur compounds from the lubricating fractions of California crude oils has demonstrated the efficacy of the still used in this work.

The bureau added a large number of samples to its collection of domestic and foreign crude oils and made available fundamental information on their properties as sources of material for the manufacture of various commercial products.

The motor-gasoline situation in the United States apparently has become more complicated during the past two or three years. In consequence the semiannual surveys of the bureau have been extended in scope to include approximately 300 samples collected in 20 cities. The Reid vapor-pressure test, sulphur content, and gum content were added to the determinations; for the first time results as to antiknock values were published.

Other problems.—Engineering field studies of surface equipment and underground conditions were made in the Cotton Valley and Zwolle fields and Richland crater area, Louisiana, the Salt Flat, Roberts-Settles, and West Texas fields, Texas, and the Oklahoma City field, Oklahoma.

Valuable evaporation data were obtained on new types of oil-tank roofs, and the advantages of using light-colored paints and higher-working-pressure valves on bulk storage gasoline tanks were determined.

A cooperative study was reported as to the behavior of aluminum as a tank material for high-sulphur oils. A preliminary report was prepared on tests of the corrosive action of hydrogen sulphide in combination with oxygen and water vapor. A report was assembled on the hydrogen-sulphide content of the gas produced in high-sulphur fields.

Studies of hydrogen sulphide from the safety viewpoint were continued, as were investigations of other safety problems in the oil fields and at refineries.

Approximately 3,200 miles of pipe line, with a daily capacity of 86,500 barrels of gasoline, have been constructed in the United States. A report on the engineering and economic phases of the transportation of gasoline by pipe line was prepared.

Work on the synthetic production of hydrocarbon motor fuels from natural gas by means of heat, pressure, and other agencies was done in cooperation with the helium division, and a large-scale laboratory unit was erected. This new experimental plant will permit the thermal decomposition of greater volumes of mixed gases and natural gas than could be used in the preliminary work on pyrolysis as described in the publication, Production of Motor Fuels from Natural Gas.

Conclusions.—Results of the work of the petroleum and natural-gas division during the fiscal year proved that the fundamental factors which apply to the solution of the problems of the petroleum industry and the natural-gas industry are definitely interrelated. The present problems pertaining to (1) flow of gas through pipe lines, (2) estimating reserves, (3) gaging and controlling natural-gas wells, (4) increasing the recovery of oil and related problems of flow of oil, gas, and oil-gas mixtures through porous media, (5) solubility of natural gas in crude oils, (6) vertical flow in wells, of which knowledge of flowing temperatures and pressures at various positions in the wells is so essentially a part, (7) injection of gas into partly depleted sands, and (8) migration of gas in reservoir sands are all essentially one large group of correlated research within the bureau. A common fundamental relationship seems to govern all of these problems. The coordination of petroleum chemistry and refining studies into one general research project also proved feasible and advantageous. The major problem of this section deals with the identification of sulphur compounds and other harmful substances in crude oils and their segregation and removal by better fractionation and subsequent chemical treatment. Research has been planned to dovetail more closely than heretofore. The result has been a grouping and correlating of scientific facts by the bureau; the industry has used these in the engineering and economic solution of its problems of production and transportation of oil and gas and the manufacture of products from these parent materials.

Recommendations.—If the petroleum and natural-gas division is to keep in the fore rank of research organizations, its needs have not changed materially from those determined by a committee of the American Petroleum Institute and reported by that committee to the Committee on Mines and Mining, United States Senate, Seventieth Congress, second session on Senate bill 2079, Part II, Febru-

ary 15, 1929, under the title, "Report on Necessary Fundamental Present and Future Problems of Petroleum Research Work by the U. S. Bureau of Mines." In its present scope of activity the Petroleum Experiment Station, Bartlesville, Okla., is restricted owing to lack of proper working quarters. In the temporary corrugated-iron structures on the property it is almost impossible to obtain necessary constant-temperature conditions, and the floor space in these temporary buildings is altogether inadequate. The Bartlesville station needs an engineering research laboratory building.

At the San Francisco petroleum field office, drastic curtailment is in effect with reference to the petroleum bibliography issued monthly as Recent Articles on Petroleum and Allied Substances, compiled by the Bureau of Mines in cooperation with the American Petroleum Institute and the Special Libraries Association. With the invaluable aid of the Special Libraries Association this publication has grown until its abstracts include the essential articles pertaining to oil and gas in almost every technical publication, including United States and foreign patents.

EXPERIMENT-STATIONS DIVISION

The experiment-stations division has administrative control and coordinates the work of the 11 experiment stations at which the technologic studies of the bureau are mainly conducted. In addition, the chief engineer of the division has technical supervision over the bureau's research work on nonmetallic minerals, coal preparation, and coal chemistry. The problems being studied at the various experiment stations are outlined in this report under the technical divisions supervising the work described.

Work of different stations.—The Pittsburgh Experiment Station, at Pittsburgh, Pa., is by far the largest of the 11 stations and chiefly handles problems 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 devoted exclusively 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 Tuscaloosa, Ala., gives particular attention to the problems of the coal, iron, and nonmetallic industries of the Southern States.

The Nonmetallic Minerals Experiment Station, at New Brunswick, N. J., conducts inquiries into the treatment and use of numerous important nonmetallic mineral products. At present, efforts are being concentrated on the development of methods for the utilization of polyhalite, greensand, leucite, alumite, and other minerals as sources of potash.

The North Central Experiment Station, at Minneapolis, Minn., works on problems connected with the beneficiation and smelting of

the 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 is also a center for the bureau's ore-dressing studies.

The Northwest Experiment Station, at Seattle, Wash., investigates the beneficiation and utilization of the coals and nonmetallic minerals of the Pacific Northwest and Alaska.

The Pacific Experiment Station, at Berkeley, Calif., conducts highly specialized physical-chemical research concerned chiefly with the determinations of fundamental metallurgical constants.

The Rare and Precious Metals Experiment Station, at Reno, Nev., carries on research as to more efficient production of rare and precious metals, including the utilization of low-grade ores not now commercially of value. Its present major problem is the development on a pilot-plant scale of a zinc-smelting process resulting from laboratory work at Berkeley.

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.

The Intermountain Experiment Station, at Salt Lake City, Utah, studies the treatment of complex low-grade ores and lead smelting.

NONMETALLIC MINERALS

The two most important investigations of nonmetallic minerals completed in the past year were the studies on the properties and preparation of the iron oxide mineral pigments of the United States and on the recovery of fine phosphate ore formerly going to waste.

Iron oxide mineral pigments of the United States.—This investigation is the first of its kind in which a comprehensive study has been made of domestic materials occurring in various parts of the United States, with the object of finding suitable sources of pigments to replace French ocher, Italian sienna, Turkish umber, and others. Tests for color, tinting strength, fineness of grain, oil absorption, and iron oxide content were made on 267 samples of both used and unknown minerals of possible pigment value. Most of the samples were received through the cooperation of various State geological surveys. The majority were in crude condition and required preparation. Data on washing and grinding were therefore obtained. Most of the materials were of no commercial value, because of poor color, poor tinting strength, and low content of iron oxide. Fifty samples had possible commercial value for ocher or sienna of some grade—21 for burnt siennas, 19 for metallic browns, 5 for umbers, and 3 for blacks. The clear, bright yellow ocher or sienna is the rarest of these iron oxide pigment materials. The natural red earths are in most instances inferior in depth of color and clearness of hue to the artificial red produced by the calcination of iron oxide. The red-brown earths are plentifully distributed over the whole country, and occur in far larger quantities than the yellow-brown earths. Six yellow ocher samples—2 from Alabama, 3 from Illinois,

and 1 from Mississippi—gave a clearness of color hue similar to that of imported French ochers. The other 44 ochers classed as having commercial possibilities may be used for local service in districts where exact duplication of the French ocher is not necessary. Data on the occurrence of these mineral pigments, the nomenclature, and the common methods of classification and testing of many of the commercial mineral pigments used in this country are also given in a report now being prepared for publication on this subject.

Recovery of fine phosphate ores.—Four years ago, when the Bureau of Mines first began its study of the recovery of phosphate from the land-pebble deposits of Florida, only simple washing and screening were employed. Losses were high, averaging nearly 50 per cent of the phosphate in the ore. During the work in the district, better screening methods, flotation, agglomeration, and now classification have been introduced.

As a result of bureau studies, two companies have introduced hydraulic classification to treat current tailings, and one of them has substituted classifiers for the 20-mesh screens which had proved unsatisfactory. Five classifiers in three plants have increased the yearly phosphate recovery about 81,000 tons.

Extraction of potash from its minerals.—Drilling by the bureau in Texas and New Mexico has proved the existence of extensive beds of polyhalite, a hydrous potassium-magnesium-calcium sulphate. Research by the Nonmetallic Minerals Experiment Station during the past two years has led to the development, on a laboratory scale, of the following processes for the recovery of potash from this mineral:

1. Production of potassium sulphate and potassium magnesium sulphate by leaching calcined polyhalite and evaporating the liquors.
2. Production of potassium sulphate by the addition of schonite to the extract from calcined polyhalite.
3. Precipitation of magnesia and gypsum to give a product of potassium sulphate by the addition of slaked-lime slurry to the extract from calcined polyhalite.
4. Extraction of calcined polyhalite and partial evaporation of the liquor, which is then used to leach more calcined polyhalite; the resulting residue, calcium-potassium sulphate (syngenite), can be sold as a fertilizer or leached for the recovery of potassium sulphate.
5. Extraction of calcined polyhalite with a cold potassium sulphate solution to yield a residue of potassium-calcium sulphate, from which the potassium sulphate can be extracted by leaching with hot water.

All the processes listed yield solutions or residues containing magnesium salts. These offer a potential raw material for the production of metallic magnesium.

Studies of these processes, which have been proved feasible on a laboratory scale, are now being continued in the chemical-engineering laboratory on a larger scale.

While the laboratory studies on polyhalite were in progress other potash-bearing minerals were also being investigated. A thorough review of the literature on utilization of greensand was completed and a bibliography published as Bureau of Mines Bulletin 328. An economic study of processes for extraction of potash from wyomingite ad alunite likewise was completed and prepared for publication.

A carload sample of wyomingite has been received at the Nonmetallic Minerals Experiment Station for use in developing extraction methods.

Effect of wetting on rate of solution of fine materials.—From the studies on the rate of solution of gypsum and anhydrite it has been found that finely divided substances may dissolve less rapidly than somewhat coarser ones, owing to a tendency of the extremely small particles to cluster together and thus prevent complete contact of their surface with the dissolving liquid. When the samples of these very small particles are first thoroughly wetted by dispersing in a small amount of water to give a fluid suspension, the rate of solution on addition of excess water is increased as much as fivefold. This fact can be utilized in any industry where finely divided material must be dissolved or hydrated.

The bulking properties of fine particles.—In connection with its development of an accurate sizer for microscopic particles, the Nonmetallic Minerals Experiment Station of the bureau studied the bulkiness, or volume per unit of weight, of material through a 200-mesh sieve. It was found that the bulkiness increased with decrease in particle size below a certain critical diameter but was constant above this size. For all powders the same functional relationship was found to hold between the voids per gram and the surface mean diameter. The differences in the constants for the different powders appear to depend chiefly on the particle shape. These results, of interest to the chemical and nonmetallic industries dealing with finely powdered materials, such as cement, pigment, and mineral filters, are published in Industrial and Engineering Chemistry (vol. 22, 1930, pp. 1206–1208), in a paper entitled "The bulking properties of microscopic particles."

Production of vitrified-magnesia crucibles.—To meet the demand of the bureau for chemically inert, highly refractory and impervious crucibles to be used in its slag research, the Nonmetallic Minerals Experiment Station has developed a vitrified-magnesia product which offers promise of success. A method has been developed for forming these crucibles under hydraulic pressure in such a way as to provide equal compression on the bottom and sides. This assures uniform density and eliminates cracking. After removal from the mold, the crucible is dried at a low temperature and subsequently fired in a high-frequency induction furnace up to 2,600° C. The resulting crucibles are translucent and impervious to liquids at ordinary temperatures. They are much more resistant to the action of ferrous silicate slags than the nonvitrified type of crucible heretofore commonly employed.

Purification of kaolin.—At the Northwest Experiment Station further progress was made in the development of a satisfactory spray evaporator for dewatering kaolin suspensions. Estimated costs have been reduced below $3 per ton. A test for estimating the blunging property of a clay was devised and utilized in studying the purification of a number of materials. It was also used in comparing the dispersion properties of different paper fillers. A study has been completed of the use of Pacific Northwest kaolins as paper fillers. At least one satisfactory clay has been found, and possibly others will prove suitable.

COAL WASHING

Laboratory investigations at the Northwest Experiment Station of the bureau have shown the superiority of tables over other treatment devices for cleaning fine sizes of coal. The Southern Experiment Station, realizing that greater use could be advantageously made of tables in the Alabama coal regions, has concentrated its efforts during the past year on showing coal operators the applicability of this method. Samples of coal from the following beds have been thoroughly studied and tested during the year: Mary Lee (3 mines), Brookwood, Black Creek, and Thompson. Particular attention was given to the study of sulphur elimination on samples from the Corona, Jefferson, Pratt, Nickle Plate, and Carter beds.

The Mary Lee bed is the most important producer of coking coal in Alabama. A detailed study of its amenability to beneficiation has been made at 8 operating mines distributed over an area 40 miles long and 15 miles wide, in the most productive part of the Warrior coal field. The washing characteristics are similar everywhere, except near the extreme northwestern border, where a high percentage of impure coal complicates the washing problem. Well-operated washing plants in other parts of the field should reduce the ash in the Mary Lee coal to 8.5 to 10 per cent, depending on the size of the material washed.

Present practice with this coal produces a middling product generally used for boiler fuel. The production is far in excess of the demand for high-ash fuel. Much of this middling is therefore run to waste, and the contained coal is lost. During the year tests were therefore run to determine the possibilities of re-treatment. Tabling the material finer than $\frac{3}{16}$ inch from one middling (which size contained practically all the available coal) yielded about 75 per cent of the coal in a 9.5 per cent ash product.

Flaky impurities, known in Alabama as rash, add to the difficulty of the washing problem, since they tend to concentrate with the clean coal. The present studies, however, show that these impurities should not interfere to any great extent with the washing operation if fine sizes of coal are washed separately from coarse sizes, with equipment designed for cleaning fine coal.

CONCLUSIONS

The nonmetallic minerals investigated during the year were iron oxide pigments, phosphate ore, potash minerals, gypsum, anhydrite, magnesite, kaolin, and coal.

The completion of a report covering iron oxide minerals suitable for pigments, occurring in various parts of the United States, should stimulate the production and use of domestic materials to replace much of the pigment material now imported.

The four years of research now completed on recovery of phosphate ore has increased the phosphate recovery in Florida about 81,000 tons annually.

Two years of research on methods of extracting potash from domestic polyhalite has resulted in the laboratory-scale development of five possible processes. The most promising of these are now being developed on a chemical-engineering scale.

In connection with the study on the use of gypsum and anhydrite as retarders in Portland cement, it has been discovered that the predispersion of finely divided particles in a little water increases by fivefold the rate of solution in water. Also, the bulkiness of fine, dry powders increases with decrease in particle size below a certain critical diameter but is constant above this size. These facts can be utilized in the nonmetallic filler and pigment industries.

The superiority of table concentration over other treatment for cleaning fine sizes of coal has been shown, and the washability of various southern coals has been determined.

These and similar accomplishments, valuable as they are, represent but a small fraction of the problems awaiting solution by the bureau in the broad field of nonmetallic minerals and the products that might be made therefrom.

RECOMMENDATIONS

The Seventy-first Congress authorized the appropriation of $350,000 for the establishment of an experiment station at College Park, Md., near Washington, on ground deeded to the Federal Government by the State of Maryland. This station will supply the need that has been urgent for some time for research facilities which require the personal contact of the bureau's division heads in Washington. It will supplement and assist the experiment stations scattered through the various mining districts of the country and will provide a station for the mining industry of the southeastern part of the United States. Appropriation of the $350,000 for construction of this station should be made as soon as possible.

Completion of the iron oxide-pigment survey and the phosphate-ore-beneficiation studies enables the Southern Experiment Station to start the study of flotation of Alabama graphite and makes it possible for the Northwest Experiment Station to study domestic chalks and whitings. Other problems awaiting solution which can not be studied with the present limited staff of 14 technical men on nonmetallic and coal-washing research are:

1. The relation of the type of equipment used for crushing stone to the fracture and shape of particles produced.
2. The most efficient method of screening gravel for the elimination of undesirable (nondurable) particles.
3. The chemical and physical characteristics that influence the durability of cherts and shales when used as concrete aggregates.
4. The technology and fuel economy of lime burning.
5. The suitability of clays associated with the coal seams of the Pacific Northwest for use in the manufacture of tile and brick.

The nonmetallic-minerals industry lacks technical organization and research facilities. The stimulation of the cheaper production of new nonmetallic products is a proper function of the Bureau of Mines, for which an additional appropriation of $100,000 a year should be made.

EXPLOSIVES DIVISION

Photographing explosion waves.—In the belief that the pressure wave produced by an explosion is a factor in the ignition of fire damp, a method of photographing these waves has been developed in

which the pressure waves from the detonation are made visible by means of an optical arrangement utilizing the change in refractive index of a gas when compressed. Cameras of special design have afforded means of photographing the pressure wave and the gases invisible to the naked eye as they left the explosive.

For wave velocities higher than the velocity of sound in air the exposure must be of the order of one-millionth of a second or less. Such an exposure was obtained when a powerful static spark was used as a means of illumination. By this means the transfer of detonation from one cartridge of explosive to another when the cartridges are separated by an air gap has been investigated. The detonation of the second cartridge is brought about by the transfer of the pressure wave from the first cartridge. This wave has a critical velocity, below which detonation of the second cartridge will not take place. These velocities have been measured by means of a wave-speed camera. It seems possible from these findings that a method for the measurement of the sensitiveness of explosives to explosion by influence, which is more precise than the methods now in use, may be developed.

Effect of electric and magnetic fields on flame propagation.—The possibility of arresting and extinguishing explosions of inflammable gas-air mixtures has been studied. In the tests a stationary flame was maintained between two 80-mesh wire-gauze electrodes. The voltage between the electrodes was increased until the flame was extinguished. Experiments have demonstrated that it is possible to control the direction of movement, the speed, and the form of the flames in such inflammable gas-air mixtures, and even to extinguish them at will. The practical application of these results to the control of explosions in inflammable gas-air mixtures remains to be developed.

Mechanism of gas explosions.—Explosions of inflammable gas-air mixtures in mines, industrial operations, private dwellings, street manholes, and sewers exact an annual toll of life and property damage. To prevent explosions a knowledge of the intimate mechanism by which they are initiated and propagated is necessary. The explosion of ozone gas, which chemically is the simplest, is being investigated. The concept of chain reactions has been used to explain their mechanisms. Explosions of ozone, sensitized by bromine vapor, are initiated at the walls of the containing vessel by the projection of active molecules into the gas phase. A series of chain reactions, which then proceed from these initial active molecules through the gas phase, eventually lead to an explosion.

Inflammability of gases and vapors.—New compounds are frequently being introduced into industry for use as anæsthetics, refrigerants, fumigants, and insecticides. The fire and explosion hazards of ethylene, ethylene oxide, vinyl chloride, ethylene dichloride, carbon disulphide, ethyl ether, methyl ether, and ethyl alcohol have been determined and made known.

To safeguard the process of insulating wire by coating it with cellulose acetate, a cooperative investigation is being carried out to determine the lower limit of inflammability of acetone-air mixtures.

Flame temperature of gases.—In a study of the physics and chemistry of combustion and explosions the flame temperatures of Pitts-

burgh natural gas, ethane, propane, butane, isobutane, ethylene, propylene, butylene, and hydrogen mixed with air have been determined by the sodium-line-reversal method.

Manhole explosions.—Investigations of the explosion hazards in manholes and other underground openings have been carried out in cooperation with the cities of Boston, Mass.; Newburgh, N. Y.; Bayonne, N. J.; and McKeesport, Pa. Explosive atmospheres are created in these openings under streets by gas leaking from gas mains, electrolytic generation, decomposition of sewage, or vapors from gasoline. Explosions can be minimized by adequate ventilation, repairing leaking gas mains, and rigid control of disposal of inflammable liquids. Stringent inspection methods have been devised.

Chemical laboratory.—The chemical laboratory force continued its routine work of analyzing samples of explosives submitted for test for permissibility or suitability. It continued the inspection of material purchased for the Panama Canal Commission. It investigated accidents and outrages, especially passing upon suspected devices. An accurate method for the analysis of permissible explosives containing hydrated salts has been developed.

Physical testing.—This working unit was also engaged in its routine labor of testing explosives and blasting devices for permissibility and suitability. During the fiscal year 22 explosives were placed on the active permissible list and 18 on the inactive list. During the same period 3 blasting devices were placed on the active permissible list and 1 on the inactive list. On June 20, 1931, there were 131 permissible explosives and 5 permissible blasting devices on the active list.

Investigations undertaken led to the publication of The Lower Limits of Inflammability of Natural Gas-Air Mixtures in a Large Gallery, Toxic Gases from 60 Per Cent Gelatin Explosives, and The Trauzl Block Strength of Dynamites. Much attention was given to devising apparatus and developing technique for the determination of the relative ignitibility of explosives. Special tests of explosives were made for other Federal agencies and for State and municipal authorities.

Liquid-oxygen explosives.—The causes of premature explosions of liquid-oxygen explosives (L. O. X.) and their handling and use have been investigated under a cooperative agreement.

Most accidents with L. O. X. have been traced to the high degree of sensitivity of the cartridge to mechanical shock. To determine and eliminate the causes of this sensitivity a study of the different characteristics of various absorbents was made. The study included tests on the effect of the type of absorbent, of particle size, of sensitizing and desensitizing materials in the absorbent, and of the purity of the liquid oxygen. The results of the L. O. X. investigations of the bureau will be published in a bulletin at an early date.

Conclusions.—From this review of the activities of the year, it is obvious that all center about the testing of explosives for permissibility. The various investigations have for their object chiefly improvements in the nature of these tests. Field tests by which to check the permissibles offered in commerce should doubtless be conducted on a more extended scale.

Recommendations.—Continued experience has confirmed the opinion that the permissibility method of control of explosives for use in coal mining, introduced in 1909, has operated with marked success as a safety measure. Recent statistics show that 56 per cent of the explosives consumed are used for purposes other than coal mining. It remains now to aid metal mining, quarrying, and other engineering operations in which these other explosives are used by the creation of a stability list for the promotion of safety and efficiency in these industries.

HELIUM DIVISION

The Bureau of Mines Amarillo helium plant, designed and constructed by engineers of the bureau, completed its second fiscal year of operation on June 30, 1931. It started to operate in April, 1929, and its performance has improved steadily.

During the past fiscal year, the plant was never called upon to produce at full capacity; however, during this period practically every record of former production was broken. The total production for the year (11,362,730 cubic feet) and the production for June, 1931 (1,515,220 cubic feet), are the largest amounts ever produced by any helium plant in the world in like periods; also, shipments for the year (10,905,970 cubic feet) and for June, 1931 (1,527,210 cubic feet), are the largest ever made in any year and month, respectively. The average recovery for the year (85.6 per cent) and the average purity (97.8 per cent) are also new records.

The net expenditures from the Treasury required to operate and maintain the plant and gas field averaged only $10.36 per thousand cubic feet of helium for the year. This is the lowest yearly average cost ever attained. Also a new monthly cost record was established in June, 1931, when helium was produced with net expenditures of only $5.95 per thousand cubic feet.

Helium production.—The plant, operated solely by employees of the Bureau of Mines is about 7 miles west of Amarillo, Tex. It contains two helium-separation units, with a total capacity of more than 24,000,000 cubic feet of helium per year.

The investment represented in the plant is about $700,000, and 22,008,690 cubic feet of helium has been produced at a total net cost for operation and maintenance of $252,434.53. This 22,008,690 cubic feet, at the commercial rate of $34 per thousand, would have cost $748,295.46. Thus a saving of $495,860.93, about 70 per cent of the cost of the plant, has already been made through its operation.

Natural-gas supply.—Helium-bearing natural gas is supplied to the plant from the Cliffside structure, a few miles northwest of Amarillo. This was a virgin field when operation of the plant was started. During the fiscal year 1931 the bureau completed purchases of gas rights in fee in 11,433 acres of this land, and gas-royalty rights in 16,737 acres in which leasehold gas rights had previously been acquired. At the close of the year, the Government owned gas rights in fee in 28,170 acres, and leasehold gas rights in 9,228 acres on the structure. In addition, it held a contract to purchase the fee gas rights in 11,834 acres. It is expected that this contract will soon be consummated by transfer of title. Steps to acquire the remaining gas rights in the structure are progressing satisfactorily.

In all, rights in about 50,000 acres, covering the entire structure, will be acquired. The natural gas is transported from the Cliffside structure to the plant through a welded pipe line 11 miles long.

Cryogenic laboratory.—The work of the laboratory includes research for improving methods of helium production and purification, a survey of the Nation's helium resources, and plant control. The present efficiency of plants used by the Government for production and purification of helium is due in a large measure to research work done in this laboratory.

Problems that received attention during this year included determination of equivalent volumes of helium containers, removal of carbon dioxide from gases, gas analysis, separation of helium by electrical methods, thermocouple calibration, determination of small amounts of carbon dioxide in gases, and cycles for helium purification to meet special conditions. Two reports were published, and material for four additional papers was prepared. There were collected and analyzed 280 samples of gas from 22 States and three foreign countries. Helium-bearing gas fields in seven States were studied.

Plant control involved 1,491 chemical analyses of various types, in addition to maintenance and calibration of many indicating and recording instruments.

Value of work.—When the present program of acquirement and development is completed, the plant, gas rights, wells, and pipe lines will represent an investment of about $2,200,000. It has been pointed out that $495,860.93 has been saved during the 27 months of operation. At this rate the saving would pay for the entire investment in about 10 years. However, the savings will be much greater than they have been in the past, because of larger production and increased efficiency. In addition, the Amarillo plant and Cliffside structure give the Government assurance of adequate supplies of helium for the future that could not be obtained through commercial purchase.

Cryogenic laboratory research is developing data and methods for helium production and purification; the survey of helium resources is locating supplies of helium-bearing natural gas for the time when the demand for helium will be much greater than now. Engineers of the bureau are carefully collecting data on the Cliffside structure and are carrying on research that will ultimately be of inestimable value to the natural-gas industry.

Conclusions.—In view of the high record of low-cost helium production, above indicated, the continued operation and development of the Amarillo plant and Cliffside structure and the prosecution of the auxiliary low-temperature and field research need no further justification. These activities are essential to the Government's aeronautical program. The wisdom of facilitating them in every possible way seems obvious.

Recommendations.—In view of the anticipated growing demand for helium by the Government, especially with reference to increased use by the armed services, as portended particularly in the building of the Navy's new dirigibles, it is recommended that expansion of the Amarillo plant be kept in mind as a possible future project and that the research carried on in the cryogenic laboratory for the purpose of increasing the efficiency and lowering the cost of helium production and purification and developing methods for utilization

of residue gas for other than fuel purposes be carried on with unflagging persistence. To develop further data relative to the capacity and life of the Cliffside structure additional wells should be drilled; these will also aid in production control and provide for maintenance of future gas supply. The bureau investigations concerning discovery and conservation of helium-bearing gas resources throughout the country, looking forward to future adequacy of gas supply, should be maintained.

OFFICE OF THE CHIEF MINING ENGINEER

The work of the chief mining engineer includes: Chairmanship of the mine-safety board; investigations at the Experimental mine; chairmanship of the British-cooperation committee; and special studies.

Mine-safety board.—Three decisions were approved in the interest of safety in coal mining, in which recommendations were made for wetting machine-coal cuttings at the coal face and wetting the top of loaded cars in the working place; for the removal of machine cuttings from the cut and from the mine; and for the lessening of the formation and distribution of coal dust in haulage ways. Such decisions regarding safety in mines, when approved by the director, form the basis of teaching and policy of the bureau. The board continued its studies of explosion-disaster reports. It reviewed and made recommendations concerning mine-safety questions submitted by various mining organizations.

Experimental mine.—The outstanding achievement of the Experimental mine was the completion of an investigation on the strength of plain concrete stoppings for use in coal mines. When such a structure is carefully recessed into solid coal or rock walls, it acts as an arch against horizontal pressure, such as from an explosion, and its strength is roughly 10 times that of a similar concrete beam with unrestrained ends. It was found that the strength varied as the square of the ratio of thickness of the stopping to its span, and the data obtained permit design of stoppings to resist any pressure up to 100 pounds per square inch, under conditions normally met in mining. A preliminary report was published, and a comprehensive bulletin is in press.

An investigation of rock-dust barriers for checking dust explosions in coal mines was also completed. Three designs of barriers were thoroughly tested and are recommended for general use when installed exactly as designed by the bureau. Four other designs were also recommended for use under special conditions less commonly met. A preliminary report was published and a bulletin is in press.

Reports were published on the effectiveness of different size rock dusts in preventing coal-dust explosions in mines, on the initiation of coal-dust explosions by gas explosions, and on coal-dust explosions caused by electrical ignition. A report, entitled "Experiments to Determine the Minimum Amount of Coal Dust Required for Propagation of a Mine Explosion," is in press.

British cooperation.—A bureau investigator detailed to the British Safety in Mines Research Board studied the effect of certain gases in changing limits of explosibility of various mine gases and gases produced by explosives.

A British exchange investigator at Pittsburgh started studies of new laboratory methods for determining the explosibility of coal dust. Already valuable results as regards inflammability have been obtained from laboratory tests of coarse dust.

Because some of the mine-safety studies relate to spontaneous fires in mines and to the explosibility of coal dust in air, it has been necessary to study the constitution of coals, the characteristics of coals of different geologic ages, and the behavior of component parts. This subject, previously investigated jointly, is reported in Bulletin 340.

A report covering the work accomplished by the cooperation in the calendar year 1930 and listing publications emanating from this cooperation since its beginning is in press.

Revision of bulletins for Federal Board for Vocational Education.—The chief mining engineer directed the revision of four bulletins concerning phases of safety in mines used by the Federal board in its field classes. He revised the bulletin on coal-mine ventilation.

Ground movement and subsidence from mining.—Valuable additions to the bureau's collection of data on subsidence were made, including material on Kolar gold mines and American and Scottish longwall coal mines.

Conclusions.—The decisions of the mine-safety board are used by engineers of the bureau in making recommendations for increased safety in mining. They represent the collective opinion of the bureau's specialists as to safe practices, safety devices, and safety methods in mining.

During the year many tests have been conducted in the experimental mine, the results of which have practical application in the prevention of coal-dust explosions. With the present allotment this mine can not be operated throughout the entire year. With increased funds additional tests of valuable practical application to the needs of the mining industry could be conducted.

British cooperation eliminates duplication of work by the two countries. It enables results of scientific tests and investigations when attacked by different methods to be checked. Much benefit has been derived from the different viewpoints, and the efficiency of research workers has been increased.

Each country makes available to the other its facilities, personnel, instruments, and information. The bureau also exchanges data on mining studies with mining organizations of other foreign governments—France, Germany, and Belgium—but no funds are available for closer cooperation. If the present formal cooperation could be extended to the mining organizations of other countries, the practical results accruing from additional funds might far outweigh moneys so expended.

Recommendations.—The experimental mine should operate more than two-thirds of the year. Data are desired on several new and vital subjects; various important studies await completion. It has been suggested that the British cooperation be broadened in scope of studies and also to include mining organizations of other countries. Some of the publications most in demand are out-of-date and might well be made current with present practice and conditions of mining.

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ECONOMICS BRANCH

COAL DIVISION

The coal division supplies an information service for producers, distributors, and consumers of coal, which includes a series of current reports, issued promptly and designed to follow the short-time movements of the market. The long-time developments are covered by the detailed annual reports which provide a background for the prompt current service and trace the underlying economic changes in the industry.

During the past year this service has been greatly strengthened through an arrangement for systematic reports on coal distribution. As in many other industries, there is urgent demand for data on the marketing and consumption of the product, and the 1931 appropriations for the first time authorized establishment of such work. The movement of coal has been traced from each producing field to each consuming State or district. The information is obtained from railroad-traffic records, which are found to be a better source than the books of the producing companies. The division has now completed an analysis of the distribution of bituminous coal, anthracite, coke, and fuel briquets, and the results are being published. This information is in wide demand by both producers and consumers of coal; sales managers and wholesalers need such figures in establishing sales quotas and in seeking new markets; traffic managers need them in adjudication of freight rates and in handling traffic problems.

The bureau's market service was further strengthened by a Monthly Coal Market Summary, designed to meet the needs of the busy executive. This review brings together, largely in chart form, all the leading factors of the market, including production, stocks, distribution, consumption, car supply, employment, weather conditions, and trend of prices. It was begun in January, 1931, and supplies a long-felt need.

During the year the division has collected and compiled data showing the quantities of the various fuels consumed by the Federal Government. This is a phase of the marketing service of the bureau that has not been covered before, and the data will prove of interest and value to producers and distributors as well as to those branches of the Government service that purchase and consume fuels.

The bituminous-coal industry is passing through a mechanical revolution, both in mining practice underground and in preparation methods on the surface. To enable operators and manufacturers of equipment to follow these developments, the coal division has arranged periodic reports on changes in operating practice and in mechanical equipment of the mines. These data help the equipment makers in gaging the market and help the operators in deciding on investment in new machines. It is not possible, of course, to publish the sales of a single manufacturer, but it is possible to classify equipment by types and to show, for example, that use of one class of mechanical loaders is rapidly increasing, while another is barely holding its own. These studies, warmly supported by both manufacturers and mine operators, illustrate a service that the bureau should develop further.

Results of special investigations published during the year covered the following subjects, among others: Growth of mechanical cleaning by wet and pneumatic methods; underground loading machines, scrapers, face conveyors, and pit-car loaders; distribution and consumption of fuel briquets; recovery of creosote oil and phenol at by-product coke ovens; liquidation in a number of operating companies and increasing concentration in hands of larger companies; and the flow of bituminous coal into industry and trade.

Although not easily measured in value of results, much of the service of the division is represented by responses to requests for specific information through correspondence and personal contact with visitors seeking assistance in their individual problems. These specific services, with necessary extensive data files which make them possible, constitute a practical part of the division's work.

Government fuel yards.—The Government fuel yards purchase and distribute coal, coke, oil, and wood 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 40 heavy-duty and light-delivery trucks; its coal-handling plant has a storage capacity of 13,000 tons of coal. During the fiscal year 1931, coal aggregating 282,164 gross tons was delivered to more than 500 points; of the total tonnage, 177,366 tons were delivered by trucks from the coal-handling plant, and 104,797 tons were shipped in railroad cars direct to plants having their own railroad sidings. The trucks traveled 187,499 miles, with an average round-trip haul of 6.53 miles. The sales value of the coal was $1,399,572.71; 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 $27,679, making a total of $1,632,503. The Government fuel yards operate under a revolving fund, which is maintained by the sales of fuel and reimbursement for services.

Conclusions.—The statistical and economic information collected and disseminated by the coal division is indispensable to the successful conduct of the business of producing and selling coal and its products, as this service provides industry with the fundamental data of production, distribution, consumption, and stocks, all of which are essential to the planning of production schedules, sales quotas, and the search for new market outlets. The service is of no less value to consumers in keeping them informed of the rate of production and of current developments in the various supplying fields, of shipments to important consuming regions, and of the status of commercial stocks. This service is the more necessary at present because of the financial distress and competitive rivalries in the coal industry; such conditions have made it difficult for the trade associations to furnish the information needed. In both the national and the local fields, associations have been forced to limit their market-information services, and except for the coal journals the work of the coal division is almost the only source of information on the workings of the market.

Recommendations.—In view of the excessive production capacity of the coal and coke industries and the intensive competition of the

various fuels for the available markets, it is essential that the bureau not only maintain but strengthen its information service.

The requests made upon the coal division by the coal and coke industry itself constitute the best indicator of the future needs of the division. The industry is asking for:

Establishment of the stock report on a monthly basis instead of quarterly, as at present.

More adequate data on consumption by individual industries and the types of coal best suited therefor.

Studies of the household-fuel market. This is now the largest of all the items in the country's fuel budget, and it is steadily growing. It absorbs the equivalent of 160,000,000 tons of fuel a year and is the biggest prize in the coal market. It is the scene of active competition between the several fuels and of rapid technical change. Yet it remains the great blind spot in the market.

Studies of the distribution and marketing of coke, fuel briquets, manufactured gas, and other by-products of coal processing similar to those already established for bituminous coal.

More complete information on mining practice and natural conditions in the mines, as affecting costs of production, efficiency, and prices.

Interpretative studies of problems of production control, original consolidations, and cooperative sales agencies.

MINERAL-STATISTICS DIVISION

When a mining engineer plans to reopen an old mine or district it is necessary to know what the mine or district has produced in the past, the metal content of ore, and other pertinent facts. The necessary data regarding production from the old mining districts have been compiled by this division, by States, and often by individual mines, and released in the regular series of annual reports and in other publications, covering the five principal metals. To date the district figures for all the principal metal-producing States except California and Oregon have been published, and compilations covering the latter are nearing completion.

Supplementary information, including maps and special studies, is available at bureau field offices at Denver, Colo.; Salt Lake City, Utah; San Francisco, Calif.; and Joplin, Mo. At each of these offices miners or prospectors may obtain information from experienced specialists thoroughly familiar with mining practice and having intimate knowledge of the mining operations and districts in a particular territory.

Washington office.—Through annual statistical surveys covering each of the important nonmetallic minerals, except the mineral fuels, the nonmetals section compiles essentially the only market information available regarding supply, demand, and utilization of specific minerals. For example, the annual printed statistical studies of fuller's earth, magnesium, stone, and potash are typical of the 24 annual printed reports on nonmetallic minerals made possible by the work of this section; also preparation of a quarterly gypsum statement and a current monthly cement report showing production, capacity, shipments by States, and stocks of Portland cement.

The metals section collected statistics on all metals of commercial importance. These figures were published in preliminary form shortly after the first of the year and later in final detailed form in 19 annual reports on mineral resources of the United States. The marketing data on domestic metals were supplemented by the work

of the foreign minerals production section, which compiled information on the mineral resources and production of foreign countries.

Sixty-one separate economic studies of minerals were prepared for publication in the annual volumes, Mineral Resources of the United States. One separate study summarizing the mineral statistics published in the various reports was prepared. The Bureau of Mines entered into cooperative agreements for statistical studies with certain State geologists and mine operators.

Field offices.—As already stated, the four field offices of the division supply practical mining men with useful economic information. In addition, these offices prepared for publication 12 annual reports covering metal mining in all of the important producing areas. Of special interest to the mining industry was the further development of the division's annual compilation on secondary metals, prepared by the bureau's office at Joplin, Mo.; this compilation indicates more accurately the importance of these materials in affecting the marketing of primary metals.

Conclusions.—The economic and statistical records maintained by the mineral-statistics division tie in with the everyday work of the operator and the mining engineer. If funds and personnel become available it is planned to undertake the following services and studies, which are of interest to the mineral industry: (1) A thorough economic analysis of the part played by the supply of secondary metals in the marketing of primary metals; (2) the preparation of a new bulletin on the mining districts of the western United States; (3) a complete statistical study of the metal content of mill concentrates. With these figures and the data already available on mine production and actual smelter output, for the first time it will be possible to calculate the over-all loss in metal production; (4) the starting of a monthly statistical service to furnish current information on the production, distribution, and uses of lime.

Recommendations.—This division's greatest need seems to be for understudies to replace many of the staff whose age indicates resignation or retirement from the Government service in the not-distant future. It is estimated that the division can expect to lose one-third of its staff in the next five years. Each retiring employee carries away years of specialized training and experience that can not easily be ingrained into an understudy in a short time. To delay the timely provision of needed understudies would impair the work of this division and also seriously affect other governmental agencies dependent upon this work, and in order that this objective may be reached it is suggested that financial provision more commensurate with the needs of this work be made available without undue delay.

PETROLEUM-ECONOMICS DIVISION

There is need for an analysis of the domestic gasoline supply and demand. Both the American Petroleum Institute and the Federal Oil Conservation Board have been endeavoring recently to forecast gasoline demand over certain periods, and have stated that the lack of definite data has made their task difficult. Some months ago the petroleum and natural-gas division began a study of the economic factors influencing domestic demand for gasoline; no report has been made available, but valuable information is being gathered, and in the near future the bureau will publish data regarding this subject.

The chief of the division was appointed chairman of the voluntary committee on petroleum economics. On request the bureau submitted to the Federal Oil Conservation Board a report forecasting crude-oil and gasoline supply and demand during the period April 1 to September 30, 1931. Comparing the estimated figures with those in the subsequent Bureau of Mines Monthly Petroleum Statement, it was found that for the first two months (no further comparison was possible) motor-fuel demand was in line with this forecast. Motor-fuel demand is the most important single item, as the overproduction or underproduction by refineries, in relation to motor-fuel demand, determines largely the economic position of the industry.

Special studies.—A second study dealing with the production and distribution of liquefied petroleum gases, such as propane and butane, which are finding wide use for domestic and industrial heating purposes, was prepared and the results issued as a press statement showing that marketed production of these gases in 1930 increased 81.4 per cent over the 1929 production.

The division assisted in the preparation of other material for the use of the Federal Oil Conservation Board and different committees and agencies engaged in the study of economic problems related to the conservation of natural gas. The increased production of this commodity, coupled with the continuing expansion of distribution facilities, has increased the public interest in natural-gas developments. An analysis of natural-gas supply and demand was prepared for the use of the American Gas Association at its annual convention in October, 1930. During the year special analyses relating to natural gas were prepared for other organizations of national importance.

Reports relating to trends in gasoline supply and demand were prepared and presented before the National Petroleum Association and the American Petroleum Institute. Gasoline demand during past months has been influenced by unusual business and weather conditions, the first tending to reduce demand below normal and the second having the opposite effect of raising the level above the usual requirements.

Information was compiled, from a survey of 201 representative cities in the United States, regarding street paving during the 10 years ended December 31, 1929; this was issued as an information circular. Since street paving and road surfacing take 44 per cent of all asphalts sold in the United States, such trends show probable national demand for asphalt.

Regional studies of the Atlantic coast and Pacific coast areas were prepared and issued. In its distribution studies the division has restricted its activity mainly to fuel oil, issuing an information circular and a printed pamphlet on this subject.

Monthly and annual reports.—Annual reports were published reviewing achievements in particular branches of the petroleum and allied industries. Previously these reports were mostly statistical, but they now include an economic discussion of the industries.

Among the annual reports issued by this division are the five Mineral Resources chapters—Petroleum, Natural Gas, Natural Gasoline, Carbon Black, and Asphalt and Related Bitumens. There are also published certain annual reports such as Petroleum Refinery

Statistics, Petroleum Refineries in the United States, and Survey of Cracking Plants.

Monthly reports reflecting changes in the fundamental economic factors of the oil industry were prepared and distributed to approximately 2,800 concerns and individuals in the United States and foreign countries. The wide interest in this statement is shown by the diversity of groups on the mailing lists.

Foreign studies.—Based on annual totals, Venezuela held its position as the second largest petroleum-producing country, with Russia (Union of Socialist Soviet Republics) in third place. Persia, Rumania, and the Netherland East Indies all recorded increased production, while the decline in Mexican production continued and Mexico dropped from fourth to seventh place among the world's oil-producing countries; Persia succeeded Mexico in the fourth position, followed in order by Rumania and the Netherland East Indies.

A press statement showing natural gasoline in a number of foreign countries was issued. The United States produced more than 90 per cent of the world's yield of natural gasoline. These figures are the first that have been assembled showing completely the world production of all natural gasoline in 16 countries outside of the United States.

Contacts regarding information available in the division were made by bureau personnel, either by letter, telephone, telegraph, or in person, with 2,051 individuals or organizations from February 1, 1931, to June 30, 1931.

Conclusions.—Reports issued by this division form the basis for the correlation of supply and demand in the production and marketing of petroleum products; for the preparation of various reports of oil companies; and for the determination of policies by producers and by purchasing agents and other officials of oil-consuming industries. They are used extensively by members of the Congress in connection with proposed legislation, and by the Federal Oil Conservation Board in preparation of reports to the President. The fundamental data on production, consumption, distribution, and stocks are available from no other source, and are essential to the rational planning of policies and schedules of both the producing and consuming industries.

Recommendations.—The division has been unable to meet adequately the numerous requests for accurate information regarding the recent developments in the natural-gas industry. One unit of the division should devote all of its time to the natural-gas industry.

In view of the excessive productive capacity of the petroleum industry and the necessity for balancing supply and demand, it is important for the Bureau of Mines to assist in the gathering of more comprehensive data on the consumption of petroleum products, particularly motor fuels, which will aid the industry and the Federal Oil Conservation Board in forecasting demand over certain periods. An expanded program should be made possible.

RARE METALS AND NONMETALS DIVISION

Information supplied.—The rare metals and nonmetals division during the year answered 4,104 inquiries on various commodities, in addition to furnishing advice and assistance to several hundred

visitors. Many inquiries cover several phases of the same industry; the questions answered were more than 10,000. The field of the division's work covers all the metals and their ores, except 11 items assigned to the common-metals division, and all the nonmetallic mineral substances except sulphur (and pyrites) and fuels. In a typical month inquiries are received regarding 100 or more different commodities. Reports were made as to the economic possibilities of 1,156 mineral specimens submitted for examination. A plan for more effective coordination of the work of identifying mineral specimens with similar services rendered by other Federal and State agencies was being perfected toward the end of the year. The division has enlarged its facilities for bringing buyers and sellers together, and, in response to the special requests, furnished 714 lists of possible buyers and 307 lists of producers of mineral commodities included within its field. Similar trade lists, including names of consumers, dealers, importers, and producers are incorporated into the publications prepared by the division on various subjects and receive wide circulation.

Publications.—A total of 75 manuscripts was completed by members of the division during the fiscal year. Of these, 43 were information circulars embodying general economic studies of mineral commodities, including a number of the rare elements such as hafnium, rhenium, and masurium, with regard to which little or no data had hitherto been published outside of the highly technical reports of scientific research. An economic paper on crushed-stone production contained a 25-year history of production and price statistics from which future trends may be forecast; conditions requisite for successful conduct of a crushed-stone enterprise were also reviewed, and detailed data were presented with respect to specifications, costs, and capital requirements. A somewhat similar report on granite appeared in the form of an information circular. Two reports of investigations were also prepared for publication by the bureau, and 19 papers prepared by members of the division during the year were accepted for outside publication.

A new service, giving current figures of gypsum sales and production within about three weeks after the expiration of each quarterly period, was launched, and by the end of the year 100 per cent of the producing firms were voluntarily furnishing their figures.

Because of the importance of light weight combined with adequate strength in modern construction, available data on such materials are being compiled by the building-materials section. One report dealing with light-weight aggregates has aroused so much interest in the possibilities of these materials in the construction field that a series of 10 reports on light-weight building materials, both natural and synthetic, is now in preparation.

The mining codes and ancillary legislation of 9 additional countries were abstracted during the fiscal year. At the close of the year efforts were being made, with the cooperation of the State Department and the Bureau of Foreign and Domestic Commerce, to assemble the necessary data for abstracts of the laws of 14 remaining countries or self-governing territories in order to complete the series of abstracts of foreign mining laws. A total of 52 of these papers had already been published.

Conclusions.—That the commercial services rendered are of great benefit is amply affirmed by the number of appreciative letters received from purchasing agents, producers, mineral dealers, engineers, and investors. Hundreds of unsolicited testimonials as to the value of the division's services to industry are recorded in the files.

The publications program includes the preparation of monographs summarizing, for each of the more important commodities in its diverse field, available statistics of production, prices, and foreign trade, outlining present and prospective uses, giving the high lights of technology of production and preparation for market, and analyzing the competitive status of the domestic industry. For the present, reports giving general information on particular commodities have been issued, subject to revision. In many instances a second report is issued covering available data on foreign and domestic deposits and sources of supply where this feature of the industry can not be adequately treated in the general report. A third step, provided the size of the industry warrants the expenditure of the necessary time, is to undertake a detailed examination into consumption and markets. The demand for these circulars has been so great that editions are quickly exhausted and a number of papers have been reprinted several times. Many of them have been copied in whole or in part in private publications in various parts of the world, and all have received favorable comment in the trade press. From an administrative standpoint, a further advantage of these publications has been the fact that they have enormously reduced the labor of answering routine inquiries, many of which can be answered better by a general report than by a long specially prepared letter.

Recommendations.—Although the effort required to answer inquiries has been greatly reduced by the issue of needed publications and by building up adequate information files, the number of inquiries steadily increases. The variety of questions is growing; correspondents who have received information on one subject often come back for data on another or with additional questions on the same subject.

Funds are needed for additional personnel and for continuing the publication of information circulars and keeping pace with increasing volume of service work. There is need for market studies and more intensive economic-service work, especially in the field of building materials. Additional support is needed for surveys of the fundamental factors in cost of production of commodities in the division's field.

COMMON-METALS DIVISION

Publications.—A unique publication of the common-metals division in 1930 was a chart in colors showing United States mine production of gold, silver, copper, lead, zinc, and iron ore for 1928, the most recent year for which complete data were available. Based upon a map of the United States, it includes diagrams visualizing the comparative values of production of the several metals, by States and by the country as a whole; the relative importance of States in production of each separate metal; the location of mining districts, the metals they produce, and the magnitude of their productions; finally, it includes a table of the fundamental data used so that the broad

visualization by diagrams may be followed, if desired for precise studies of production, by their resolution into detailed figures. There has been a brisk demand for this chart by schools and colleges, economists, and the mineral industries.

Another product of the division for which there has been pronounced demand was Economic Paper 10, Economic Relations of Silver to Other Metals in Argentiferous Ores, which answered the widespread queries for facts regarding silver production to replace numerous suppositions that were more or less conflicting. In this paper the sources of world production of silver were precisely determined and analyzed, and the relation in production of silver to other metals was shown quantitatively as a basis of reasoning for the solution of many problems regarding silver.

Summarized Data of Tin Production was completed and will be published as an economic paper of the production series already established by papers on gold, silver, copper, lead, and zinc production. Systematic accumulation of production data of other common metals has likewise been conducted, with a view to publication as the record of each individual metal becomes complete.

An information circular summarizing general data regarding sulphur was published. Another such circular regarding pyrite has been completed and is in course of publication; likewise, an information circular on chromite was completed during the year and is in course of publication.

Monetary use of silver and gold.—Widespread discussion of possible future shortage of gold required for monetary purposes led to an extensive collection by this division of data bearing upon monetary use of both silver and gold. This material has been studied and compilations of data have been made for use in answering inquiries and for possible future publication.

Biennial canvass of tin and silver consumption.—Occasional canvasses of tin consumption in the United States, conducted by this division, have been so well received that a biennial canvass of tin consumption has been established, one of which is now in progress for 1930. Likewise, a canvass of silver consumption in the United States has been undertaken, a report on which has been nearly completed. All important centers of silver manufacture were visited in establishing the basis of this canvass. For both of these consumption canvasses there has been demand by the industries concerned.

World resources of chromite.—Recent extensive discoveries of chromite, chiefly in Africa, and the development of previously known deposits made desirable a special study in regard to world resources of chromite. The results of this study were published in Mineral Resources of the United States and were likewise presented before a technical society for discussion.

Scope of work.—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.

Data files.—Large additions were made to the data files of the division relating to its subjects. These records now cover nearly 4,000 topics. They are an important means of assisting the public with information, in response to numerous inquiries received by the division. There is much to indicate that the value of this material

will be steadily enhanced by time and by its gradual improvement through indexes and topical summaries.

Conclusions.—Much effort is consumed in answering inquiries of the public and Government agencies in regard to the common metals. Further effort is consumed in the preparation of chapters for volumes of Mineral Resources of the United States. Constant study of their subjects by the specialists of the division is required, so they may keep informed as to current developments in the industries concerned with the common metals. Intensive studies are also conducted of special topics, which may prove of service through rendering more apparent and more readily available for use the factual foundations of important problems.

Recommendations.—Too large a part of the personnel must devote its efforts to work of a routine nature; comparatively little time is available for preparation of fundamental economic data. A small increase in personnel would make possible significant special studies. For this reason, a moderate increase in personnel for this division is recommended.

PRINCIPAL MINERALOGIST

The principal mineralogist has begun the revision of A Glossary of the Mining and Mineral Industry, published by the bureau in 1918. The glossary as published contained more than 20,000 terms. Certain parts need revision, and during the 13 years that have passed great numbers of new terms have come into use so that additions have become necessary. The terminology of mining and metallurgy has become so complex that such a revised glossary is more than ever required.

As a part of its service, the bureau has collected ores, minerals, and their products. These are also used as the foundation for exhibits at various expositions. This office labels, polishes, and arranges these specimens.

Conclusions.—Preparation of copy for the new glossary of the mining and mineral industry will be continued; also chapters on four of the rare metals. The exhibits of ores and minerals have a definite educational value, both to prospective buyers and to the many students who have made use of them.

Recommendations.—There seems to be need for extension of this work, and it is recommended that increased personnel be provided.

HEALTH AND SAFETY BRANCH

HEALTH DIVISION

Carbon monoxide.—Chemical and pathological studies of asphyxia by carbon monoxide and by atmospheres deficient in oxygen have been in process for the past two years to learn the response of the human organism to asphyxial environment, with the object of devising a procedure for treating moribund cases of carbon monoxide poisoning. It has been observed repeatedly that many of these cases terminated fatally, even though respiration had been restored and the carbon monoxide removed from the blood.

The investigations on carbon monoxide included studies of comparatively rapid asphyxia resulting from exposure to conditions

that cause death in 20 to 30 minutes and comparatively slow, prolonged asphyxia resulting from exposure to conditions that maintain a serious state of asphyxia during 8 to 16 hours with possible death at the end of that period.

In the first instance it was found that exposure for 20 to 30 minutes to 0.6 per cent by volume of carbon monoxide in air produced 75 to 85 per cent carbon monoxide hæmoglobin and resulted in death at the end of the exposure, with a severe perivascular and perineuronal edema of the brain as a whole.

Exposure for 8 hours to 0.18 to 0.22 per cent of carbon monoxide and for 16 hours to 0.13 to 0.16 per cent resulted in death with much more severe perivascular and perineuronal edema of the brain than in the first case.

Chemical warning agents for fuel gases.—Since 1926 the Bureau of Mines has been studying chemical agents to be used in mines and in fuel gases as a warning of irrespirable atmospheres. During the past two years the American Gas Association has been cooperating in an investigation of the possibility of adding to gas small amounts of odorous or irritating substances to warn persons of the escape of gas and thus aid them in avoiding poisoning.

The hazard to health and safety of a contaminated atmosphere depends not only on the potential deleterious action of the atmosphere but also to a considerable extent on the warning it gives of its presence. Such gases as sulphur dioxide and ammonia are more injurious than carbon monoxide in equal concentrations, but when present in concentrations below those causing immediate harm their odor and irritating properties create intolerable atmospheres. If carbon monoxide possessed a similar warning property, poisoning from it would be confined to involuntary exposure and would not even include suicide, because fatal concentrations would be intolerable.

In making this study 89 substances were selected on the basis of known properties or as being representative of groups of substances that might possess the desired properties of warning agents. Certain groups were discarded immediately because of toxicity, corrosion, or lack of stability.

It was found that neither pleasant nor unpleasant odors were effective in waking persons, unless present in high and impractical concentrations. Eye, nose, and throat irritants were effective in practical concentration.

The substances that appeared to be most promising in the laboratory were studied in field tests, where attention was given to transmission of the warning agents, warning properties of the impregnated gas, reaction of consumers, and complaints regarding leaks. Crotonaldehyde is one of the best warning agents of the nose and throat-irritant type. It awakened sleeping persons during laboratory tests. In field tests it gave warning of leaks; these tests indicated that it would be transmitted satisfactorily through the lines after they had become saturated.

Allyl alcohol, although not used in field tests on account of lack of material, has properties that make it similar to, or possibly better than, crotonaldehyde as a warning agent of the irritant type if used in dry-gas systems.

Ethyl mercaptan was found to be the best warning agent of the unpleasant-odor type. The field tests indicated that it would be transmitted satisfactorily through the lines after they had become saturated. It has a distinctive odor and is noticeable in high dilution with air. It was effective in attracting attention and caused more complaints of leaks than any other material used in field tests. It does not awaken sleeping persons unless present in high and impractical concentrations.

Odors give immediate warning to persons entering highly poisonous or explosive atmospheres, but irritants are more satisfactory for warning persons exposed to such gases when gradually increasing from low concentrations.

Actual full-scale use over extended periods, under the various conditions that prevail in the distribution and utilization of relatively odorless gases, will be necessary before final judgment can be reached as to the practical value and commercial feasibility of adding warning agents to fuel gases.

Physical examination of miners.—Physical examinations of men employed in and about the lead and zinc mines in the Picher mining district have been made since July 1, 1927, with the purpose of reducing the incidence of silicosis and tuberculosis among the miners and safeguarding the general health of the miners and their families.

According to the condition of the men as revealed by the examinations, they are classified as negative, as having first, second, or third stage silicosis, or as having silicosis complicated with tuberculosis, or as having uncomplicated tuberculosis. Although the tabulation and analysis of the data are not completed, the results thus far have indicated a decreasing incidence of silicosis and tuberculosis among the miners of this district.

WORK OF FIELD SECTION

Health among miners.—A study was made, in cooperation with the safety division, of the accident experience of the coal mines of Utah for the period 1918 to 1929, and a report was submitted for publication.

A study of the causes of death among coal miners, metal miners, and employees of metallurgical plants has been made in a group of States where those industries are in operation. For purposes of comparison, similar mortality data as to farmers and all other males over 16 years of age have been gathered from the same group of States with a view to ascertaining the relative effect of the several branches of the mineral industry on the health of the employees. The results indicate that the major causes of a higher proportional death rate among miners than among farmers are accidents in coal mining and tuberculosis in some metal-mining districts.

Silicosis study.—During the year 3,695 physical examinations were made, as compared with 7,843 last year. Although there was an increase in the percentage incidence of silicosis in the district, there was an actual decrease in the number of silicotics. Last year 1,195 silicotics were employed and this year 669. The increase in the percentage incidence of silicosis during the year is probably due to the fact that men with first-stage silicosis are not barred from the

mines; and although there was a reduction in the number of men employed, the old men with families, who have in a large number of instances early silicosis, have been retained.

WORK OF LABORATORY SECTION

Pathological and biochemical laboratories.—Studies were continued during the year on the toxicity of and health hazards involved in the use of aniline and dimethyl aniline, benzol, dichloro-difluro methane, carbon monoxide, and methanol.

A statement describing the laboratory experiments and investigation of the health experiences of men in the methanol industries and of men using methanol antifreeze was published, and a review of the literature on the toxicity of this substance was submitted for publication. From observations made by the bureau, it was concluded that there is no danger of poisoning from a reasonable use of methanol as an antifreeze liquid in automobile radiators.

In the study of refrigerants an investigation was made of the efficiency and suitability of acrolein as a warning agent in event of leakage of the refrigerant into air breathed by persons. The practicability and possibility of the use of acrolein for this purpose had been investigated by manufacturers of methanol products and a manufacturer of refrigerating devices. These companies asked the Bureau of Mines to make an independent investigation of this substance. It was found to be a suitable agent for the purpose. Two reports were published.

Gas-analysis laboratory.—During the year 1,913 gas samples were received and analyzed by this laboratory.

Stream-pollution laboratory.—A general review of the bureau's stream-pollution investigation, which began in 1924, was published during the year. These results show that acidity of mine-drainage water during low-water periods is not markedly higher than during normal conditions. In general, the drainage from mines in high-pyrite areas is more acid than that observed from coal beds of average or low-sulphur coals. Waste material is the main source of acidity in these mines. Pillar drawing, with subsequent caving, seems to increase the acidity of the mine-drainage water.

Gas-mask laboratory.—Commercial gas masks were approved for protection against hydrogen sulphide, petroleum vapors, sulphur dioxide, chlorine, phosgene, carbon tetrachloride, hexane, and hydrogen cyanide.

As an all-service gas-mask canister had never been tested against the oxides of nitrogen, it seemed desirable that such tests be made, as these canisters are often used by firemen in atmosphere containing such gases. The tested canisters exceeded the minimum requirement.

Schedule 14A, Procedure for Testing Gas Masks for Permissibility, was revised and published as Schedule 14B.

CONCLUSIONS

It is believed that the findings of the health division, when applied, will effect a definite saving of life and, in some instances, an indirect saving of money. This is illustrated by the work of the Picher clinic, where the protection afforded individual miners by the information

obtained from physical examination results in a definite decrease in compensable accidents.

Application of the results gained from the warning-agents investigation has shown that by the addition of such agents to fuel gases a great saving is effected in the cost of labor in finding leaks and in the consequent reduction in loss of gas when the leakage is stopped.

It is believed that through the study of the chemistry of carbon monoxide, and of the pathological results from poisoning by this gas, a rational method of treatment may be developed that will result in the saving of lives of many who have been severely poisoned and who probably would die under present methods of treatment.

RECOMMENDATIONS

Many of the studies undertaken by the health division have been in part supported by cooperating societies and companies. Some criticism has been made of this method. It would be more satisfactory to all concerned if sufficient funds could be made available by the Congress to make cooperative studies unnecessary. A course that would leave the funds free enough to carry on studies as needed would require more flexible regulations than are now in force.

SAFETY DIVISION

First-aid and mine rescue instruction.—During the fiscal year ended June 30, 1931, the outstanding accomplishment of the safety division, with its total personnel of 90, of whom 22 are engineers and 37 first-aid or foreman miners, was giving 112,220 full courses of training in first-aid or mine rescue instruction to those engaged in the mineral industries. The training courses were given in 638 communities in 39 States and Alaska; Pennsylvania led with 24,657 trained, West Virginia was second with 12,092, Alabama third with 9,553, and Kentucky fourth with 7,834. The training was distributed by branches of the industry as follows: Coal mining, 72,098; metal mining, 19,187; petroleum, 14,375; public utilities, 1,573; nonmetallic mining, 1,461; cement, 1,354; miscellaneous, 2,172. To date, the bureau's forces have given these courses of safety training in first aid or mine rescue to 581,982 persons in the mineral industries.

Up to June 30, 1931, certificates have been issued to 552 plants in the mineral industries, indicating that all of the employees of the plant have received the Bureau of Mines first-aid course. During the past fiscal year, 250 of these 100 per cent certificates were issued, covering the training of 57,695 persons.

During the previous fiscal year, the first-aid and mine rescue training work, figured on the same basis, was 113,358 as compared with 112,220 during the past year, a decrease of 1,138. Although some of this decrease may be ascribed to the adverse economic conditions, the main reason is that during at least eight months of the past fiscal year the major effort of about 15 able and active men of the 90 members of the safety division was devoted to the accident-prevention course in bituminous-coal mining, which was in preparation in 1927, 1928, and 1929, and was first formally taught in the late fall of 1930. This course, which at present is divided into 11 subjects, is for the instruction of bituminous-coal mining officials in up-to-date

methods of accident prevention; the subject is so extensive that weeks are required for the presentation of the course, and necessarily the classes are relatively small. During the approximately eight months of the past fiscal year in which the course was given, 1,455 mining officials took it in full and nearly 500 others took part of it. Mining officials in Alabama, Illinois, Indiana, Kentucky, Maryland, Pennsylvania, Tennessee, Utah, Washington, and West Virginia have received this training; the requests for the work have been so numerous that it has been impossible to comply with even a large portion of them. Many complimentary letters have been received from persons who took the course, as well as from companies whose employees took it.

The past fiscal year also witnessed the beginning of another important activity of the safety division, the issuance of certificates of competence to instructors in first aid. In the early years of the Bureau of Mines, practically all of the first-aid-training work sponsored by the bureau was done by the bureau's own field personnel. In 1926 the aid of some mining companies was enlisted in what is now known as cooperative training, in which the Bureau of Mines field men gave intensive instruction to several key men of the operating companies, who in turn gave the instruction to classes of their fellow workers; the work, however, was done under supervision of the bureau personnel, who examined the men thus trained by the company instructors, and if the men were found competent in the work, Bureau of Mines first-aid certificates were issued. This cooperative training was started in 1925 and has grown steadily in popularity in the past fiscal year; 63,804 courses were given. As the demand for cooperative training increased, it became evident that the company instructors were deserving of recognition, and it was decided to issue instructors' certificates to them; 1,532 of these were issued during the past fiscal year to instructors in 32 States. Pennsylvania led with 603, Alabama was second with 250, Ohio third with 104, and Virginia fourth with 85. As approximately 60 persons of the safety division of the Bureau of Mines are more or less actively engaged in first-aid training and are now bringing about the first-aid training of more than 100,000 persons per year in the mineral industries and as more than 200 lives are saved annually as a result of this work, it will be seen that the 1,532 first-aid instructors' certificates issued in one year can not fail to have far-reaching results in furthering safety in the mineral industries.

Meets, exhibits, and safety meetings.—The safety division forces participated in 114 first-aid and mine-rescue meets during the past year, and an average of 4 of the bureau men were present at each meet. The meets were held in 19 States and in British Columbia; more than 12,000 persons participated as contestants. The international meet sponsored by the Bureau of Mines was held in Louisville, Ky., with 59 contesting teams from 11 States and Canada, representing coal and metal mining, nonmetallic mining, smelters, and the petroleum industry.

During the year the safety division participated in 14 exhibitions, held in California, Indiana, Kentucky, Ohio, Oklahoma, Pennsylvania, Texas, Utah, and Virginia; the attendance was slightly under 50,000. In several of these, the bureau gave spectacular demonstra-

tions of the explosibility of coal dust; in others, various types of safety equipment were shown; and in some, safety equipment or safety methods in mining were demonstrated.

Safety division personnel attended approximately 450 safety meetings in addition to first-aid and mine-rescue meets; at nearly all of these one or more safety papers were read or safety talks were made by bureau men; the attendance was around 100,000. It is believed that during the past fiscal year, in the aggregate of its various activities, safety division personnel came into fairly direct personal contact with more than 300,000 persons engaged in the mineral industries; in practically every instance, some phase of the Bureau of Mines safety teachings was advanced.

Joseph A. Holmes Safety Association.—The past year has been one of unusual activity in organizing community safety clubs in the form of Holmes safety chapters; 34 new chapters were organized during the 12 months. The bureau field men made safety talks before about 125 Holmes chapter meetings during the year; each month Holmes Safety Chapter Notes, with its approximately 20 pages of mining-community safety data was issued and circulated, not only in the Holmes chapter communities but also to all State mine inspectors and to numerous others interested in safety and health work in the mineral industries. During the year Congress gave official recognition to the Holmes chapter work, in that an appropriation was made available July 1, 1931, for the employment of two engineers to forward the work.

Most of the work incident to the Joseph A. Holmes Safety Association sponsored by the United States Bureau of Mines falls upon the safety division, and much time and effort must be expended in assembling and correlating the several hundred excellent safety records and other data placed before the association for possible awards.

The recognition given the mineral industries for meritorious safety effort or records, through these Joseph A. Holmes Safety Association awards, has a good effect in stimulating safety effort; numerous good safety records have been made in mining during the past few years, either through efforts to secure one of these awards or to equal or surpass the record on which some previous Holmes award or awards have been made.

Rescue work at disasters.—As usual, the safety division personnel had numerous contacts of various kinds with accidents, explosions, and fires in the mineral industries. The most serious disaster was that of the Sunday Creek Coal Co. in Ohio on November 5, 1930, with 82 fatalities.

Safety inspections.—Another duty of the safety division is to make safety inspections and reports on mines and other plants in the mineral industries; there was no cessation of this type of safety work during the year.

Publications on safety.—Another feature of the work of the safety division is the publication of information on safety; as usual, numerous safety pamphlets have been sent out to the industry.

Appreciation of safety work.—That the work of the safety division is more definitely appreciated, as time goes on, may be inferred by the fact that great numbers of congratulatory letters and published statements commending the bureau safety work are being received;

in some instances these come from foreign lands. More than 200 letters of commendation or statements were received by the safety division the past year.

Conclusions.—The first half of the year 1931 was one of the safest in the history of mining in the United States; only three major explosions, exacting 41 lives, occurred in the bituminous-coal mines of the United States—none occurred during the months of February, March, April, May, and June, 1931. Individual States, notably Pennsylvania, Alabama, and Kentucky, had splendid records. Pennsylvania bituminous mines have not had a major explosion for more than two and one-half years, breaking all known records in this respect. Individual mines—coal, metal, and nonmetal—have worked for long periods (months, and in some instances well over a year) without the occurrence of a single lost-time accident, probably the outstanding mine being the Cleveland Cliffs Iron Co., of Michigan. It has six operating mines, every one of which has established a record of more than a full year of operation without the occurrence of a single lost-time accident. Generally the mines, mining companies, and States that are establishing these fine safety records are those cooperating closely with the personnel of the safety division; it is felt that this active cooperation is at least in part responsible for these record accomplishments in safety. There is now good reason to believe that mining will soon take its place with the railroads and other industries which have shown that industrial work can be done with due regard to the health and safety of those engaged in it.

Recommendations.—The present needs of the safety division are, in the order of importance:

1. Fires and explosions in mines (coal or metal) are generally preventable. Fortunately, the past year was relatively free from disasters. Nevertheless, during the year, the safety-division personnel was in contact with nearly 50 mine fires and explosions, in which well over 200 persons were killed. The investigations that followed these disasters, as well as other investigations in and around mines at ordinary times by safety-division personnel, have convinced bureau safety engineers that there is usually a lack of appreciation of obvious dangerous practices and conditions and that if data found in these investigations and now embodied in confidential reports were published many accidents and disasters might be avoided. Bureau practice is and has been to hold these reports confidential, except that a copy is usually sent the company concerned. It may soon be advisable to ask Congress for authority to investigate mines, with the right to publish promptly the findings, including conclusions and recommendations; such authority would not mean that the bureau would have police power in so far as concerns the enforcement of recommendations, as the recommendations, if reasonable and feasible, will usually be put into effect. However, speedy publication of the data obtained and the recommendations made would unquestionably be highly educational in so far as concerns safety practices in other mines.

2. The safety division's present chance to reach the worker is now the first-aid course; this valuable contact may eventually be lost, because with the training of more than 100,000 workers annually (397,799 have been given the training during the past five years) it will be only a few years until most of those in the mineral indus-

tries will have been so trained. The talking moving picture unquestionably is the best method available to replace first-aid training in reaching the worker with safety doctrines. An appropriation of approximately $100,000 should be made available to the safety division with which to prepare and place into operation a series of 10 or 12 talking moving pictures on safety in mining, showing the mine workers (the face worker, the motorman, the timberman, the electrician, the fire boss, the shift boss, and all the rest) the safe way to do their work.

3. The accident-prevention course in bituminous-coal mining, started in the fall of 1930 and given to mine officials, is so popular and the number of those in the safety-division personnel available and able to give this course is so small in proportion to the number of requests for the work that it will be several years before the present requests for it can be fulfilled. When the first-aid training decreases, as it undoubtedly will within the next few years, many of the men thus released may not be able to teach the accident-prevention course.

In addition, it is desirable that similar courses of training be prepared and made available for the anthracite industry, for metal mining, for quarrying, and for the petroleum industry. In order to extend the presentation of the accident-prevention course in bituminous-coal mining, as well as for the preparation and presentation of similar courses in other branches of the mineral industries, as above indicated, the present personnel of the safety division should be increased by at least 4 engineers familiar with bituminous-coal mining, 2 familiar with anthracite mining, 2 familiar with metal-mining safety, 2 with intimate knowledge of cement and quarry work, and 2 with knowledge of petroleum safety needs. These engineers should be at least of associate grade; hence, each should have an allotment of at least $4,000 per year to cover salary and expenses.

4. The last Congress appropriated $7,850 for two engineers to engage in the forwarding of mining-community safety organizations, chiefly the Holmes safety chapters. This was a welcome start, but the work should be pressed vigorously in every State in the Union where mining is being done, and at least one full-time man should be assigned to this type of work for every five or six States; hence, the safety division would require at least six additional engineers for this important phase of mining safety work.

DEMOGRAPHICAL DIVISION

Annual safety contest.—Outstanding instances of the operation of mines and quarries with perfect safety records, or with unusually low accident rates, were revealed by a safety contest which was conducted by the bureau. This contest was based on a statistical study of accident and employment reports submitted by all competing companies. Three hundred and thirty-seven mines and quarries participated in the contest during the past year; of this number, 72 plants were operated without an accident to any employee serious enough to prevent the employee from returning to work on the day following the accident. Thirty-four States were represented. Trophies were awarded each of five companies that established the best safety performances in their respective groups: Anthracite mines, bituminous-

coal mines, metal mines, nonmetallic-mineral mines, and quarries and opencut mines. Lively interest is shown in this form of accident-prevention effort, which is sustained throughout the year by constant watchfulness, by both management and men, to enable the mine or quarry to win as favorable position as possible in the contest.

Nonfatal accidents in coal mines.—A new statistical study was begun during the fiscal year to determine the number and causes of nonfatal injuries in all coal mines in the United States. Heretofore, complete statistics on this subject have not been available, although a definite knowledge of facts concerning the causes of accidents is essential to the safeguarding of life of the men employed in the mines. Accidents are at present injuring more than a hundred thousand coal miners every year. About 95 per cent of these injuries are, fortunately, of only a temporary nature, but these temporary injuries disable the injured employees about 22 days each, as an average. The aggregate period of disability for all employees injured by accident is, roughly, the equivalent of more than 5,000 men disabled for 365 days each. Wage losses to these men, estimated at $5 a day and assuming that but for their injuries they might have worked a full year, are between 7 and 8 million dollars a year, in addition to which other serious financial losses, direct and indirect, fall upon the mining companies and ultimately upon the coal-consuming public. These losses form one of the serious problems that confront the coal-mining industry. Without discounting adverse conditions chargeable to other causes, apparently losses from preventable accidents are in some measure responsible for the unprofitable condition in which some companies find themselves. As an aid in helping to reduce these losses, as well as for the purpose of preventing unnecessary suffering from accidental injuries, the bureau hopes to make available to the mining companies, and to others who are interested, periodic statistical data and analyses that will assist the companies in formulating and conducting their programs of accident-prevention work.

Statistics on health and safety.—The demographical division conducts statistical investigations into matters affecting the health and safety of persons employed in the mining and allied industries. The object of the work is to make available to the industries, to insurance carriers, rate-making bodies, and to the public, all information that can be revealed by statistical analyses, as an aid in promoting health and safety.

The work of the division is so conducted that independent statistical studies are made of the accident hazards of each major branch of the mineral industry, with the exception of petroleum and natural gas. It is hoped to include the important petroleum and related industries, when funds and adequate facilities can be procured.

Progress in accident prevention.—During the past fiscal year, special studies of reports from a large number of mining and quarrying companies revealed substantial progress in the prevention of accidents in 1930. These reports were from many of the larger operating companies in the United States, and are believed to afford a reliable forecast of what complete returns for the year will show when similar information has been received from all operating companies.

Reports from metal-mining companies that operated in both 1929 and 1930 indicated a reduction of 15 per cent in the accident rate in 1930. The number of men working at the mines was 13 per cent

less than in the previous year; the average employee worked 24 fewer days than he did in 1929. As more than a hundred thousand men are employed in the metal mines of the United States, the reduction in the accident rate in 1930 signifies an actual saving of many men from injury in the mines. The lower accident rate is the more gratifying because it was effected in 1930 under conditions which often exert an adverse influence upon safety programs, namely, intermittent or short-time operation of the mines. Regularity of employment is generally conducive to safety and the prevention of accidents. In 1930, however, when the relative frequency of accidents might have been expected to show an upward trend, the rate actually was reduced. This was true also of many branches of the mineral industry. Representative figures for nonfatal accidents in coal mines, the largest single branch of the mining industry, are not available for years previous to 1930.

Mines that produced nonmetallic minerals, other than coal, succeeded in reducing their accident rate for all injuries between 2 and 3 per cent below the 1929 level. Employment at these mines fell off 23 per cent, with the average miner working 20 days less than he did in the previous year.

The stone-quarrying and rock-products industry showed a loss of 4 per cent in the number of men employed, while the accident rate was 13 per cent lower than in the previous year. These quarries and plants were in operation 16 days less per man than in 1929. Ore-dressing plants handling metallic ores reduced their accident rate 15 per cent; the number of men employed was 11 per cent smaller than in 1929, with the average employee working 24 days less than in the year before.

The accident rate for smelting operations was 37 per cent higher than in 1929. Men employed at the smelters were 8 per cent fewer in number than in the preceding year. The period of operation during the year was approximately 8 days less per man than in 1929.

Publications.—Publications containing this information in more detail, together with statistical analyses of the causes of accidents, are furnished by the bureau to mining companies, insurance companies, and investigators of industrial safety as a contribution to the study of accidents and a means for their prevention.

Conclusions.—In order that safety work may be conducted with minimum cost and maximum effectiveness, it is necessary to know why and where accidents occur, the number of persons injured, and the seriousness of injuries resulting from the accidents. Accident statistics supply this information; with it each mining company may more intelligently direct its safety efforts as well as learn how it stands in relation to other companies engaged in similar work and in relation to the mining industry at large; insurance companies may equitably adjust their charges to mining companies to meet changes in losses due to accidents; and the State and Nation may know the extent to which the life and health of its citizens are being expended as part of the cost of production of mineral commodities. It is believed that progress in preventing accidents in mines will be promoted as mining companies place their safety programs on a sound statistical basis. Many companies have already adopted this course.

Recommendations.—It is desirable that the bureau extend its statistical service to cover the petroleum industry, for which as yet com-

plete statistics of accidents are not available; a beginning might be made through cooperation with officials of one or two important oil-producing States. This work would cost about $10,000 annually for personnel, equipment, and other expenses. Previous recommendation is renewed for about $5,000 for two additional employees to serve as understudies for trained employees and to compile accident statistics from mining publications of foreign countries for study in connection with similar records for the United States.

ADMINISTRATIVE BRANCH

OFFICE-ADMINISTRATION DIVISION

The office-administration division is charged with handling legal matters, personnel, accounting, clerical assignment, and general routine.

The work of the legal section consists in furnishing advice on all legal matters to the director and other administrative officers of the bureau, preparing important contracts and cooperative agreements, and reviewing all other contracts and cooperative agreements, in addition to other miscellaneous matters. During the past fiscal year this section completed a compilation of all Federal laws relating particularly to the Bureau of Mines and initiated a program of compiling the mining statutes of the principal mineral-producing States. A circular containing the State laws regarding mine inspectors was completed and is now in course of publication.

The duplicating section handles the multigraphing, mimeographing, roto printing, addressographing, etc., for the entire bureau.

Personnel.—On June 30, 1931, there were 805 full-time employees on duty at the bureau, including 17 employees hired temporarily for job work. They were distributed and classified as shown in the following table:

	Classification and number of appointees				
	Professional	Subprofessional [1]	C. A. F.	Custodial [2]	Total
Washington	[3] 51	8	192	68	319
Pittsburgh	[4] 90	31	53	52	226
Field in general	[5] 124	51	49	36	260
Total	265	90	294	156	805

[1] Includes instrument makers, first-aid and foreman miners, laboratory aids, assistants, etc.
[2] Includes motor-truck drivers, janitors, laborers, messengers, etc.
[3] Engineers, 23; chemists, 4; miscellaneous, 24.
[4] Engineers, 41; chemists, 40; miscellaneous, 9.
[5] Engineers, 61; chemists, 32; miscellaneous, 31.

In addition to the foregoing full-time employees, the following persons were engaged on a when-actually-employed basis: 54 cooks, laborers, etc., employed on field agreements; 110 consulting engineers, chemists, etc.; and 69 other employees holding classified, unclassified, excepted, or temporary appointments on a part-time basis, making a total of 1,038 employees, an increase of 23 as compared with the number on duty on June 30, 1930.

The property records of the bureau, as of June 30, 1931, show accounts as follows:

Real estate	$1,169,990.00
Laboratory equipment	451,444.00
Specialized equipment	498,722.00
Office furniture and equipment	372,432.00
Power-plant equipment	660,217.44
Automotive equipment	109,649.20
Electrical equipment	75,621.80
Photographic equipment	30,560.00
Hardware and tools	30,129.44
Household equipment	20,446.66
Medical equipment	15,076.00
Engineering and drafting instruments	12,122.50
Canvas and leather goods	3,650.60
Total	3,450,061.64

INFORMATION DIVISION

An important feature of the work of the information division during the past year was the increased publicity given bureau publications. A copy of the Monthly List of New Publications is now mailed to approximately 46,000 persons; special mailing lists, containing names of individuals who have asked that information be sent them regarding definite commodities or specific subjects of bureau investigations, are now maintained. This work has resulted in a more widespread circulation and use of bureau publications, particularly reports of investigations and information circulars for which the distribution has increased more than fourfold.

Publications.—During the past year the information division supervised the distribution of 356,555 copies of the free editions of the bureau's printed publications.

In addition, approximately 75,000 copies of the bureau's printed reports were sold by the Superintendent of Documents.

Numerous brief press statements, announcing the issuance of new publications or giving particulars in regard to current investigations, were furnished to the daily and technical press. These short items were widely printed and served effectively in acquainting the public promptly with the results of the bureau's work.

The information division answered more than 80,000 letters requesting publications or information regarding the bureau's activities and general mining subjects.

Exhibits.—The information division prepared, installed, and supervised the exhibition, at expositions and conventions, of 11 exhibits illustrating various features of the bureau's work.

Editorial.—During the past year, 17 bulletins, 27 technical papers, 3 economic papers, 67 mineral-resources separate chapters, and 6 miscellaneous papers—a total of 120 printed publications—were edited and sent to the printer. Owing to lack of printing funds, however, only a part of the bureau's output could be issued in this manner; consequently, 161 papers had to be published in the technical and trade press by technical societies, cooperating educational, State, and municipal institutions, or by similar outside agencies. The fact that this bureau could have only 120 printed publications printed in the Federal plant, and had to go outside to effect release of 161 papers, is worthy of note, as indicating in a striking

manner the handicap of inadequate printing allowance under which this bureau labors.

The information division also edited 107 reports of investigations and 193 information circulars. These are papers designed to supply promptly to the mining industry and the general public the essential results of the bureau's investigations, which are usually described in detail in later printed reports, or to present salient facts on subjects of interest in a concise form suitable for use in reply to inquiries.

Motion pictures.—As a means of disseminating information regarding safety and efficiency in the mineral industries, the bureau maintains what is perhaps the largest library of educational motion-picture films in the world. These films, prepared under the supervision of the information division and through the cooperation of industrial concerns which bear the entire cost of production, show where essential minerals are found and how they are extracted from the earth, manufactured or refined into useful everyday products, utilized, and conserved. The prevention of accidents and the protection of human life have been given special attention, and several pictures deal specifically with this important subject. During the past year, four new films were added to the library—Wildwood, From Mountain to Cement Sack, Construction that Endures, and Learn and Live—and five others were completely revised—Manufactured Abrasives, The Story of Dynamite, Automobile Lubrication, The Story of Lubricating Oil, and The Story of Steel.

Distribution of the bureau's films is centralized at the Pittsburgh Experiment Station, but there are 14 subdistribution centers throughout the country, selected with regard to accessibility. The films are loaned to schools, churches, clubs, civic and business organizations, miners' local unions, etc. No charge is made for use, but the exhibitor is asked to pay transportation charges. On June 30, 1931, the bureau had 890 sets of films, including 1,951 reels, aggregating 1,650,000 feet. During the year the films were shown on 17,588 occasions before an estimated audience of 2,218,900 persons.

Conclusions.—The information division, as the outlet through which the results of the bureau's scientific investigations are made available to the mining industry and to the general public, rendered valuable and efficient service during the year in editing nearly 500 manuscripts, distributing almost a million publications, preparing and circulating educational motion-picture films, and arranging instructive exhibits for display at conventions and other gatherings. Approximately 80,000 letters and inquiries were given attention; many of these were requests for information which the division was able to supply, thus saving the time of the bureau's technical specialists. Several hundred press statements dealing with the bureau's activities and publications were prepared by the division. These were widely printed in the daily, trade, and technical press.

Recommendations.—The full practical value of scientific investigations conducted by the bureau obviously can not be realized by the mining industry unless the results are made generally available in the form of printed reports. The bureau is greatly handicapped by the lack of adequate printing funds, this deficiency being strikingly emphasized by the fact that technical and trade journals had to be depended upon as the sole medium of publication for some 160 papers

during the year. It is highly important that the bureau's printing funds be increased by at least $25,000 to permit printing the results of investigations and make them available to the industry.

GENERAL CONSIDERATIONS

As before indicated, for purposes of clarity, conclusions as to work done by each of the bureau's 17 divisions are given in this report at the end of each division chapter. There various outstanding accomplishments are summarized, and to those paragraphs attention should be directed if concise impressions are sought as to what has been done by each division during the past year. Lack of space has required the omission of much material, and the conclusions are therefore condensed to the point where they are not comprehensive but are merely suggestive.

Recommendations as to future work or policy, including suggestions as to the most pressing needs as to men, material, and money, also are given in short paragraphs at the close of each chapter. It is believed that such recommendations will be understood best if cited immediately after descriptions of the work of each division, now completed or in progress.

The most outstanding need of the bureau is the new experiment station in Maryland authorized last year. This will provide laboratory facilities readily accessible to headquarters, and enable technicians, now serving only as administrators, also to function as research leaders. Preliminary exploration of new fields of research under the personal supervision of leading technical men, should result in the development of many major research projects for allocation to the field stations. It will be a great boon to the bureau if the creative abilities of its most competent scientists, now employed administratively, can be fully utilized by means of this conveniently-situated laboratory. The new facilities should assist by attracting and holding the best men available, since many of the most competent scientists demand opportunities for personal laboratory research in their own special fields, even though they are also discharging administrative duties. The Southeastern States will thus be provided with an experiment station for use in developing their nonmetallic-mineral resources. Crowded conditions in several stations will be relieved by the new facilities. The presence of this laboratory in the center of Government research institutions grouped about the Washington area will give ready opportunity for beneficial exchange of scientific thought, and will permit useful cooperation in work of mutual interest. Emergency work can be handled at the new plant, and delays will be obviated. Thus it may be seen that the completion of this project is of the utmost importance.

The bureau has accomplished important achievements during the past year and has been functioning with commendable smoothness. It is estimated that this organization has just completed one of its most successful years.

Very truly yours,

SCOTT TURNER,
Director, Bureau of Mines.

FEDERAL EMPLOYMENT STABILIZATION BOARD

FEDERAL EMPLOYMENT STABILIZATION BOARD,
Washington, July 1, 1931.

Hon. R. P. LAMONT,
Chairman Federal Employment Stabilization Board.

MY DEAR MR. CHAIRMAN: In response to your request, I am pleased to submit the following report on the work of the Federal Employment Stabilization Board during the past fiscal year for inclusion in your annual report:

LEGISLATION

The enabling legislation creating the Federal Employment Stabilization Board was approved by the President February 10, 1931. On the same date the administration of the act was placed under the Secretary of Commerce. Since the legislation is recent, it seems desirable to reprint the full text of the act in this report as a permanent record.

[Public—No. 616—71st Congress (S. 5776)]

AN ACT To provide for the advance planning and regulated construction of public works, for the stabilization of industry, and for aiding in the prevention of unemployment during periods of business depression.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress Assembled, That this Act may be cited as the "Employment Stabilization Act of 1931."

DEFINITIONS

SEC. 2. When used in this Act—

(a) The term "board " means the Federal Employment Stabilization Board established by section 3 of this Act;

(b) The term "United States," when used in a geographical sense, includes the several States and Territories and the District of Columbia;

(c) The term "public works emergency appropriation" means an appropriation made in pursuance of supplemental estimates transmitted to the Congress under the provisions of this Act.

(d) The term "construction agencies" shall mean the following departments, bureaus, and independent agencies and such others as the President may designate from time to time:

Of the Department of Agriculture, the Bureau of Public Roads, the Bureau of Plant Industry, the Forest Service, the Bureau of Dairy Industry, and the Bureau of Animal Industry;

Of the Department of Commerce, the Aeronautics Branch, the Coast and Geodetic Survey, the Bureau of Fisheries, and the Bureau of Lighthouses.

Of the Department of Interior, the Bureau of Indian Affairs, the Bureau of Reclamation, and the National Park Service;

Of the Department of the Treasury, the Coast Guard, the Public Health Service, and the Office of the Supervising Architect;

Of the Department of War, the office of the Quartermaster General, and the office of the Chief of Engineers;

Of the Department of Justice, the Bureau of Prisons;

Of the Department of the Navy, the Bureau of Yards and Docks;

The Department of Labor;

The Post Office Department;

Of the independent agencies, the Veterans' Administration, the office of Public Buildings and Public Parks of the National Capital, the District of Columbia, the Architect of the Capitol, and the Panama Canal.

(e) The term "construction" shall include also repairs and alterations, and the purchase of such materials, supplies, and equipment as may be necessary as a part of, or incident to, such construction, repairs, or alterations.

(f) The term "authorized construction" shall include those projects which have been specifically authorized by Congress, and those projects which do not require specific legislative authorization, such as repairs and alterations.

FEDERAL EMPLOYMENT STABILIZATION BOARD

SEC. 3. (a) There is hereby established a board to be known as the Federal Employment Stabilization Board, and to be composed of the Secretary of the Treasury, the Secretary of Commerce, the Secretary of Agriculture, and the Secretary of Labor. It shall be the duty of the board to advise the President from time to time of the trend of employment and business activity and of the existence or approach of periods of business depression and unemployment in the United States or in any substantial portion thereof; to cooperate with the construction agencies in formulating methods of advance planning; to make progress reports; and to perform the other functions assigned to it by this Act.

(b) The board is authorized to appoint, in accordance with the civil-service laws, a director and such experts, and clerical and other assistants, and to make such expenditures (including expenditures for personal services and rent at the seat of Government and elsewhere, for law books, books of reference, and periodicals) as may be necessary for the administration of this Act, and as may be provided for by the Congress from time to time. The compensation of the director and such experts and clerical and other assistants shall be fixed in accordance with the classification Act of 1923, as amended. The director and his staff may be domiciled in and attached to one of the executive departments. There is hereby authorized to be appropriated annually such sum as may be necessary for the expenses of the board.

BASIS OF ACTION OF BOARD

SEC. 4. (a) In advising the President the board shall take into consideration the volume, based upon value, of contracts awarded for construction work in the United States, or in any substantial portion thereof, during any three-month period in comparison with the corresponding three-month period of three previous calendar years.

(b) The board may also take into consideration the index of employment prepared by the Department of Labor, and any other information concerning employment furnished the Department of Labor or by any other public or private agency, and any other facts which it may consider pertinent.

PUBLIC WORKS EMERGENCY APPROPRIATION

SEC. 5. Whenever, upon recommendation of the board, the President finds that there exists, or that within the six months next following there is likely to exist, in the United States or any substantial portion thereof, a period of business depression and unemployment, he is requested to transmit to the Congress by special message, at such time and from time to time thereafter, such supplemental estimates as he deems advisable for emergency appropriations, to be expended during such period upon authorized construction in order to aid in preventing unemployment and permit the Government to avail itself of the opportunity for speedy, efficient, and economical construction during any such period. Except as provided in this Act, such supplemental estimates shall conform to the provisions of the Budget and Accounting Act, 1921.

WORKS ON WHICH APPROPRIATION USED

SEC. 6. Such emergency appropriations are authorized and shall be expended only—

(a) For carrying out the provisions of the Federal Highway Act, as now or hereafter amended and supplemented;

(b) For the preservation and maintenance of existing river and harbor works, and for the prosecution of such projects heretofore and hereafter authorized as may be most desirable in the interest of commerce and navigation;

(c) For prosecuting flood-control projects heretofore or hereafter authorized; and

(d) For carrying into effect the provisions of the Public Buildings Act, approved May 25, 1926, as now or hereafter amended and supplemented, in respect of public buildings within and without the District of Columbia.

(e) For prosecuting such other construction as may now or hereafter be authorized by the Congress, and which is or may be included in the six-year advance plans, as hereinafter provided.

ACCELERATION OF EMERGENCY CONSTRUCTION

SEC. 7. For the purpose of aiding in the prevention of unemployment during periods of business depression and of permitting the Government to avail itself of opportunity for speedy, efficient, and economical construction during such periods the President may direct the construction agencies to accelerate during such periods, to such extent as is deemed practicable, the prosecution of all authorized construction within their control.

ADVANCE PLANNING

SEC. 8. (a) It is hereby declared to be the policy of Congress to arrange the construction of public works so far as practicable in such manner as will assist in the stabilization of industry and employment through the proper timing of such construction, and that to further this object there shall be advance planning including preparation of detailed construction plans, of public works by the construction agencies and the board.

(b) Each head of a department or independent establishment having jurisdiction over one or more construction agencies shall direct each such construction agency to prepare a six-year advance plan with estimates showing projects allotted to each year. Such estimates shall show separately the estimated cost of land, the estimated cost of new construction, and the estimated annual cost of operation and of repairs and alterations.

(c) Each construction agency shall also prepare a program for prompt commencement and carrying out of an expanded program at any time. This program shall include organization plans. It shall also include the plans for the acquisition of sites and the preparation of advance detailed construction plans for not less than one year in advance, except where in the judgment of the board this would not be practicable.

(d) Such programs, plans, and estimates for the six-year period shall be submitted to the board and to the Director of the Bureau of the Budget. The Director of the Bureau of the Budget shall report to the President from time to time consolidated plans and estimates.

(e) Each construction agency shall keep its six-year plan up-to-date by an annual revision of the plans and estimates for the unexpired years and by annually extending the plan and estimates for an additional year.

(f) The President is requested each year, before recommending the amount of construction appropriations for the next fiscal year to take into consideration the volume of construction in the United States, the state of employment, and the activity of general business.

(g) The board shall collect information concerning advance construction plans and estimates by States, municipalities, and other public and private agencies which may indicate the probable volume of construction within the United States or which may aid the construction agencies in formulating their advance plans.

The duties of the board, as stated in the act, are fourfold:

1. To advise the President from time to time of (*a*) the trend of employment, (*b*) business activity, and (*c*) the existence or approach of periods of business depression and unemployment in the United States or in any substantial portion thereof.

2. To cooperate with the construction agencies in formulating methods of advance planning.

3. To make progress reports.

4. To collect information concerning advance construction plans and estimates by States, municipalities, and other public and private agencies which may indicate the probable volume of construction

within the United States or which may aid the construction agencies in formulating their advance plans.

ADVISING THE PRESIDENT

The act states that in advising the President "the board shall take into consideration the volume, based upon value, of contracts awarded for construction work in the United States, or in any substantial portion thereof, during any 3-month period in comparison with the corresponding 3-month period of three previous calendar years."

As contracts awarded and other related information are to be used as the basis for any action of the board, one of the first activities of the staff was to analyze the existing data relating to the awarding of contracts in order that any advice given would be based on sound facts.

The act also states that "the board may take into consideration the index of employment prepared by the Department of Labor, and any other information concerning employment furnished the Department of Labor or by any other public or private agency, and any other facts which it may consider pertinent."

A comprehensive program of research has been formulated and work will continue on the carrying out of the program. This involves considerable amount of research and analysis relating to building permits, contracts awarded, the production and shipment of building materials and equipment, the financing of construction, the employment in construction, and the costs of construction. It is not the purpose to seek original sources for these figures unless it is absolutely necessary, but rather to make contact with and rely upon other governmental agencies, private agencies, and associations in assembling the material and making it available to the board. In carrying out this phase of our activities we have corresponded with 200 associations and have had personal interviews with over 100 leaders in order to obtain current information in their particular fields.

In addition to the new material outlined above, the board's program involves gathering reliable information on industrial production, business activity, and the trend of employment so that the existence or approach of any future period of business depression and unemployment can be seen more clearly.

ADVANCE PLANNING

The planning activities of the board with all of the construction agencies of the Federal Government have progressed sufficiently to give a comprehensive picture of the problems these agencies have in developing schedules of construction through a 6-year period. The diversified requirements and practices of so many agencies in designing construction work, awarding contracts and supervising their execution, with the many additional agencies which have repair and alteration work, necessitate treating each as an entity to develop an orderly program of advance planning. A request is expected to be made on these Federal construction agencies during November for the first report on their 6-year plan. As a result of this report, the board will better understand the problem of coordinating the Federal Government's advance planning activities.

Incidental to the advance planning activities, each of the construction agencies have been asked to make monthly progress reports to the board. These reports will show the sequence of construction extending from the authorization and appropriation of funds to the completion and acceptance of each individual project. Requests are continuously being made upon these construction agencies with reference to certain phases of their work and it is presumed that the board, being informed of what is transpiring currently in each of these agencies as well as in the Federal Government as a whole, will be able to answer more completely such requests than has been possible in the past.

While it is difficult to foresee all of the services the board may be able to perform in the short time it has been organized, the work has progressed sufficiently to exhibit a great opportunity for public service in gathering and disseminating facts and in lending a hand in the retardation or acceleration of public works during periods of boom and depression.

Very truly yours,

D. H. SAWYER, *Director.*

INTER AMERICAN HIGH COMMISSION

INTER AMERICAN HIGH COMMISSION,
Washington, July 1, 1931.

Hon. R. P. LAMONT,
Chairman United States Section,
Inter American High Commission.

MY DEAR MR. CHAIRMAN: I have pleasure in submitting a brief report of work accomplished during the fiscal year ending June 30, 1931, by the United States Section of the Inter American High Commission.

During this fiscal year the efforts of the section have been very largely directed toward assisting in preparations for inter-American conferences. In cooperation with other governmental agencies, the staff has spent much time in the formulation and development of the program and plans for the Fourth Pan American Commercial Conference, to be convened at Washington this fall. Studies have been prepared, in Spanish and English, on several subjects of the agenda. A draft convention on the simplification and standardization of consular procedure has been drawn up; and projects of principles to be embodied in national legislation of the member Republics have been prepared in both languages on bills of lading, bills of exchange, checks, promissory notes, and stock corporations.

The section had made progress in the development of the recommendations of the Pan American Conference on Customs Procedure and Port Formalities. It cooperated in preparations for the Pan American Conference on Agriculture, Forestry, and Animal Industry, carried on extensive statistical research and submitted comparative data regarding production, export, and import of coffee, cocoa, rubber, and other commodities important in the foreign trade of the Latin American Republics. Members of the staff assisted at sessions of this conference.

The section has made some progress in its standardization activities, with a view to preparing for the next or Third Pan American Standardization Conference, tentatively scheduled for 1932.

The section was also represented at the Pan American Reciprocal Trade Conference, at Sacramento, Calif., in September, and at the Sixth General Congress of the International Chamber of Commerce, held at Washington, in May.

Contact with the other 20 national sections has been maintained through correspondence, the exchange of reports, and the distribution of numerous Government reports of interest to those sections.

Yours very truly,

FREDERICK M. FEIKER, *Secretary.*

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