1-1-02 9

SPECIAL
COLLECTIONS

FIFTEENTH ANNUAL REPORT
OF
THE SECRETARY OF COMMERCE
FOR THE FISCAL YEAR ENDED JUNE 30, 1927

BEA LIBRARY
3 0030 00536375 0

HF
73
.U6
U553
1927

FIFTEENTH ANNUAL REPORT

OF THE

SECRETARY OF COMMERCE

1927

PRICE 30 CENTS

Sold only by the Superintendent of Documents, U. S. Government Printing Office
Washington, D. C.

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON
1927

ORGANIZATION OF THE DEPARTMENT

[October 1, 1927]

Secretary of Commerce	HERBERT HOOVER.
Assistant Secretary of Commerce	J. WALTER DRAKE.
Assistant Secretary of Commerce for Aeronautics	WILLIAM P. MACCRACKEN, Jr.
Solicitor	
Administrative Assistant to the Secretary	HAROLD N. GRAVES
Chief Clerk and Superintendent	EDWARD W. LIBBEY.
Disbursing Clerk	CHARLES E. MOLSTER.
Chief, Appointment Division	CLIFFORD HASTINGS.
Chief, Division of Publications	THOMAS F. MCKEON.
Chief, Division of Supplies	WALTER S. ERWIN.
Director of Aeronautics	CLARENCE M. YOUNG.
Chief, Radio Division	WILLIAM D. TERRELL.
Director of the Census	WILLIAM M. STEUART.
Director, Bureau of Foreign and Domestic Commerce	JULIUS KLEIN.
Director, Bureau of Standards	GEORGE K. BURGESS.
Commissioner of Fisheries	HENRY O'MALLEY.
Commissioner of Lighthouses	GEORGE R. PUTNAM.
Director, Coast and Geodetic Survey	E. LESTER JONES.
Commissioner of Navigation	ARTHUR J. TYRER.
Supervising Inspector General, Steamboat Inspection Service	DICKERSON N. HOOVER.
Commissioner of Patents	THOMAS E. ROBERTSON.
Director, Bureau of Mines	SCOTT TURNER.

CONTENTS

	Page
Introductory statement	VII
Economic review	VIII
General indexes	VIII
Prices	IX
Agriculture	XI
Construction	XIII
Transportation	XV
Motor transport	XVI
Ocean shipping	XVII
Banking and finance	XVII
Foreign trade	XIX
Foreign trade	XXI
Progress in national efficiency	XXVII
The causes of prosperity and progress	XXIX
Elimination of waste	XXXIV
Increase of standards of living	XXXVII
Progress in development of commercial aviation	XXXIX

CONDENSED REPORTS OF BUREAUS

Administrative Divisions, Office of Secretary	Page
Need for additional space	1
International Sesquicentennial Exposition	2
Cooperation with Federal agencies	2
Disbursing office	3
Appointment division	14
Division of publications	18
Division of supplies	19
Traffic office	19
Department library	20
Solicitor's office	20
Director of Aeronautics	
Air regulations division	23
Airways division (Bureau of Lighthouses)	25
Navigation facilities on civil airways	25
Radiobeacons and telephones	26
Weather service and communications	26
Engineering construction and maintenance	27
Beacons	27
Intermediate field lighting	28
Maintenance of airways	28
Improvement in apparatus	28
Program of lighting	29
Air information division	31
Information bulletins	31
Domestic air news	31
Mapping	31
Certification of lights	32
Airway bulletins	32
Airway mapping (Coast and Geodetic Survey)	32

	Page
Aeronautical research division (Bureau of Standards)	33
Radio aids	33
Lighting	35
The 1928 research program	35
Air transport	36
Development of airways in America	36
First contract routes	36
First night service	37
To-day's air routes	37
Commercial air service	38
Private flying	38
Government participation	38
Airports and landing fields	39
Departmental cooperation	39
Air marking of cities	40
Equipment-design progress	40
Weather and flight	41
Air accidents	42
Casualties in airway flying	42
Casualties in miscellaneous flying	42
Aircraft production and trade	42
Exports	43
Trade promotion	44
Aim of the aeronautics branch	44
Radio Division	
Creation of the radio division	45
Radio inspection service	46
Radio test cars	46
Field strength measurement	47

Page
Frequency stability 48
Radio compass 48
Tube transmitters 48
Photographs by radio 48
Television 48
Amateur service 49
International radiotelephone service 49
International radiotelegraph conferences 50
International radio accounting 51
Acknowledgment 51

BUREAU OF THE CENSUS

Introduction and summary 52
Fifteenth Census 53
Estimates of population 55
Current business statistics 55
Census of distribution 59
Census of manufactures 60
Agriculture 60
Water transportation 61
Financial statistics of State and city governments 61
Vital statistics 62
Marriage and divorce 64
Religious bodies 65
Annual census of institutions 66
Census records 66
Preservation of census schedules 67
Tabulating machinery 67
Cooperation in statistical work 68
Office force 68
Field force 69

BUREAU OF FOREIGN AND DOMESTIC COMMERCE

Growth in the bureau's domestic-commerce functions 72
Attacking the problems of waste in domestic trade 73
Surveys of definite marketing regions 74
Atlas of wholesale grocery territories 75
Study of trade association activities 76
Market-research work 76
Costs of distribution—varied lines of efforts 77
Aids for other departments—notable economies effected 78
The foreign-commerce service 79
Summary of dollar-and-cents achievements 79
Specific examples of service producing substantial business 80
Varied phases of trade-promotive activity abroad 84
Special representatives abroad 91
Substantial results from district-office service 93
Creating new interest in foreign trade 93
Unique and distinctive service provided 94
Export troubles lessened or eliminated 95
Practical benefits mount into large sums 95
Typical examples of promotive activity 96
Concrete commodity service for American industries 96
Agricultural implements division 96
Automotive division 97
Chemical division 98
Foodstuffs division 100
Electrical division 101
Concrete commodity service for American industries—Continued. Page
Hide and leather division 102
Iron-steel-hardware division 102
Lumber division 103
Machinery division 104
Minerals section 105
Paper division 106
Rubber division 106
Shoe and leather manufactures division 107
Specialties division 108
Textile division 111
Specialized technical services to business 112
Commercial intelligence division 112
Division of commercial laws 113
Finance and investment division 115
Division of foreign tariffs 115
Division of regional information 118
Statistical research division 119
Division of statistics 120
Transportation division 120
Editorial division 123
Standardization work 123
Comparative statement of services rendered 124
Recommendations 125

BUREAU OF STANDARDS

General activities 127
Salaries 131
Equipment 137
General expenses 137
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 148
Investigation of optical glass 149
Investigation of textiles, etc 149
Sugar standardization 151
Gauge standardization 152
Investigation of mine scales and cars 152
Metallurgical research 153
High-temperature investigations 154
Sound investigation 154
Industrial research 155
Testing railroad-track and other scales 160
Master track scale and test-car depot 161
Standardization of equipment 161
Standard materials 163
Investigation of radioactive substances 164
Investigation of automotive engines 164
Transferred funds 165
General recommendations 168

BUREAU OF FISHERIES

International relations 172
Northern Pacific halibut convention 172
Fisheries convention with Mexico 173
North American committee on fishery investigation 174
Great Lakes fisheries 176
Upper Mississippi River wild life and fish refuge act 176

Page
Propagation and distribution of food fishes 177
Cooperative fish-cultural work 177
Relations with States and foreign governments 178
Propagation of Pacific salmons 179
Marine species of the North Atlantic coast 179
Anadromous fishes of the Atlantic coast 179
Commercial fishes of interior waters 180
Salvaging fishes from overflowed regions 180
Fishes of interior waters 181
Distribution of fish 181
Commercial fisheries and fishery industries 182
Review 182
General statistics 182
Mackerel statistics 183
Canned fishery products and by-products 183
Trade in frozen fish 184
New England vessel fisheries 184
Fisheries at Seattle, Wash 184
Shad and alewife fisheries of the Potomac River 184
Florida sponge fishing 185
Fisheries of Maryland and Virginia 185
Fisheries of the Pacific Coast States 186
Fisheries of the Great Lakes 186
Technological investigations 186
Biological investigations 188
Fishery research 188
Investigations of the fisheries of the North Atlantic 189
Investigation of fisheries of the South Atlantic and Gulf coasts 190
Oyster investigations 191
Fisheries of the Pacific coast and Alaska 193
Fisheries of the interior 194
Pathology and experimental fish culture 196
Alaska fisheries service 197
Administration of fishery laws and regulations 197
Salmon hatcheries 198
Special studies and investigations 198
Products of the fisheries 198
Alaska fur-seal service 199
General activities 199
Seal herd 199
Take of sealskins 199
Marking of reserved seals 200
Sales of sealskins 200
Foxes 200
Fur-seal skins taken by natives 201
Fur-seal patrol 201
Protection of sea otters, walruses, and sea lions 201
Vessel notes 201
Appropriations 202

LIGHTHOUSE SERVICE

Activities during year 203
Aids to navigation 204
Engineering construction 205
Improvements in apparatus and equipment 206
Administration 208
Personnel 209
Lighthouse depots 210
Vessels of the Lighthouse Service 211
Replacement of vessels 211
Lighthouse tenders 212
Lightships 212

COAST AND GEODETIC SURVEY

Page
Hydrographic and topographic work 214
Geodetic work 218
Magnetic and seismologic work 221
Tide and current work 221
Washington office 224
Chief clerk 224
Division of hydrography and topography 225
Division of geodesy 225
Division of charts 226
Division of terrestrial magnetism and seismology 227
Division of tides and currents 229
Division of accounts 230
Instrument division 231
New charts 233

BUREAU OF NAVIGATION

American shipping on June 30, 1927 236
Navigation laws 237
Inspection of motor ships 237
Load line 237
Personnel of maritime bureaus 238
Enforcement of the navigation laws 238
Preventing overcrowding of passenger vessels 243
Shipping commissioners 245
Establishment of new shipping commissioners' offices 246
Allotment notes 246
Passenger act of 1882 247
Navigation receipts 247
Publications 247

STEAMBOAT INSPECTION SERVICE

Reorganization 248
Change of name 248
A central staff 248
Personnel 250
More men 251
Salaries 252
Boilers and machinery 252
Fire 253
Excursion steamers 253
Detecting apparatus 253
Motor craft 253
Statistics 253

PATENT OFFICE

Resignations 256
Statistics 257
Other details of business for the fiscal year 260

BUREAU OF MINES

Duties 262
Finances and financial history 262
Analysis of expenditures in 1926–27 265
Property 269
Work of information division 269
Service work 270
Organization 272
Personnel 273
General activities 274
Safety in mining 275
Safety instruction 280
Health, sanitation, and ventilation 281
Efficiency in mining 284

	Page
Metallurgical investigations	286
Ferrous metallurgy	286
Nonferrous metallurgy	288
Nonmetallic minerals	293
Petroleum and natural gas	295
Helium	300
Coal and other solid fuels—coal products	302
Coal division of economics branch	306
Coal economics	306
Minerals and metals division	306
Petroleum economics division	306
Mineral statistics division	307
Statistics on mineral commodities	307
Work in Alaska	308
Educational motion-picture films	308
INTER AMERICAN HIGH COMMISSION	310

FIFTEENTH ANNUAL REPORT

OF THE

SECRETARY OF COMMERCE

DEPARTMENT OF COMMERCE,
OFFICE OF THE SECRETARY,
Washington, November 7, 1927.

To the PRESIDENT:

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

Economic review.
Foreign trade.
Progress in national efficiency.
Elimination of waste.
Increase of standards of living.
Progress in development of commercial aviation.
Condensed reports of bureaus:

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

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

Yours faithfully,

HERBERT HOOVER,
Secretary of Commerce.

ECONOMIC REVIEW

The fiscal year ended July 1 continued the economic progress which has now been characteristic of American industry for six years. It exceeded all previous records in volume of production and consumption, and in the physical quantity of exports and imports. There was very little unemployment, except during a moderate recession near the end of the year, and the rate of real wages remained higher than anywhere else in the world or than at any other time in world history. The high prosperity of the year did not represent merely an upward swing in the business cycle but was the result of that general and permanent progress the extent and causes of which are more fully set forth in other sections of this report. There were, to be sure, a few aspects of American business which were less satisfactory, as, for example, the coal and textile industries, the relatively low price of cotton with its depressing effect upon the farmers of large regions of the South, and some continued depression in agriculture of the mid-West, although improvement is taking place since the fiscal year in both sections.

GENERAL INDEXES

The accompanying table shows major economic indexes for the past 5 fiscal years. Of the 10 indicators presented all but 3 stood higher in 1926–27 than in 1925–26, and all but 2 stood as high as or higher than in any year preceding 1925–26. One of the two last-mentioned exceptions, the value of wholesale trade, is due solely to the fact that prices are lower at the present than during years immediately at the close of the World War.

The volume of output of manufacturing industry, by all odds the largest branch of productive activity, showed an appreciable gain even above the extremely high level of the fiscal year 1925–26. The improvement was not the result of an exceptionally marked increase in any particular field, but was general in practically every group of industries. Especially noteworthy is the fact that production in the textile industries, which had long been relatively depressed, was materially greater than in the preceding fiscal year.

The most conspicuous gains shown as compared with 1925–26 are in mineral production, freight transportation, output of electric current, and sales of 5 and 10 cent stores. The increase in the two items last mentioned is part of a general upward trend more marked than that in most economic phenomena. Electric current is being used in rapidly increasing quantities for lighting, for domestic power and heat, and above all for industrial power. This expansion represents

both displacement of other sources of light, heat, and power and advance in living standards and in activity of industry.

So, too, the growth of 5 and 10 cent stores represents in part a shift from other methods of distribution, although there can be no doubt that the total volume of retail distribution has also materially increased. The steadiness and expansion of retail sales during recent years is evidence of the high volume of consumption on the part of the masses of the people.

Major economic indexes

[Based upon calendar year 1919=100]

Item	Year ended June 30—					
	1922	1923	1924	1925	1926	1927
Volume of business (quantities, not value):						
Manufacturing production	89	116	115	118	127	129
Mineral production	91	119	133	129	132	149
Forest products, production	98	117	122	121	124	114
Freight, railroad, ton-miles	89	109	110	110	119	125
Electric-power production	112	136	148	158	179	198
Building contracts let, square feet	92	107	108	112	142	132
Value of sales:						
Department stores	108	118	125	126	133	136
5-and-10-cent stores	130	152	173	196	219	240
Mail-order houses	71	91	100	110	122	123
Wholesale trade	72	80	82	83	85	83

PRICES

On the whole the level of wholesale prices has been very steady during the past five fiscal years. There have been no sharp upward price movements due to boom psychology and no sudden drops due to contraction in demand.

The average wholesale price index for 1926–27 was 6 per cent lower than that for 1925–26. The index for individual months shows a decline from 152 (on the basis of 1913 as 100) at the close of the fiscal year 1925–26 to 144 in June, 1927. The decline took place chiefly between September and April. The fact that the prices of commodities in general have fallen considerably for more than two years past does not at all point to a reduction of demand. It may be partly the result of the return of various European countries to the gold standard, and the reduction of the total amount of currency, including paper, circulating in the world. There is reason to believe also that the decline has been influenced by the constant expansion of production and the lowering of costs of commodities both in America and elsewhere. If there are more goods to be bought and sold without an increase in the volume of currency in circulation, the

tendency is toward lower prices. There can be no question that as a result of falling prices there has been a tendency to lower profits.

While there have been, of course, decided differences in the price movement of certain individual commodities subject to sharp fluctuations in production or demand, eight of the nine major groups distinguished in the statistical tables showed a lower average price level in the fiscal year 1926–27 than in 1925–26. The exception is the group of commodities classed under fuel and lighting, the prices of which averaged the same during the last two fiscal years, and were somewhat higher than in 1924–25.

It may be noted that the Department of Labor has, since the close of the fiscal year, issued a revised series of wholesale price index numbers. This is based on a larger number of commodities and the commodities are given a weighting corresponding to their approximate relative importance at the present time, whereas formerly the weights were based on the production or consumption of 1919. This index has been carried back only to 1923, and naturally since that time it shows but little difference in movement from the index as previously published. It is expected gradually to compute averages on the new basis for earlier years, and it will be interesting to learn whether the change in basis will affect materially the comparison between pre-war and post-war price levels. The new index includes, for example, automobiles which in contrast with most commodities are lower in price than before the war.

During the fiscal years ending June, 1925, and June, 1926, respectively, the relation of the prices of farm products to those of other products was more satisfactory to agricultural producers than for several years preceding. There was, in fact, little difference as compared with pre-war between the index for central-market prices of farm products and that for all other classes of goods as a group. This situation changed to the disadvantage of the farmer in the fiscal year 1926–27. While prices of practically all classes of commodities fell, the decline was greatest in the case of farm products. In 1925–26 the index for farm products had averaged 152 as compared with a general average of 156 for all commodities (1913 taken as 100). In 1926–27 the corresponding figures were 138 and 147, showing a spread of nine points between farm products and the general average. The decline in the index for farm products was chiefly due to lower prices for the major cereals and especially for cotton, and in the case of the latter commodity the explanation lies largely in the phenomenal crop of more than 18,000,000 bales, exceeding the pre-war average crop by about 40 per cent, and the average of the years 1919 to 1924 by a still larger percentage.

Since the close of the fiscal year prices of farm products have advanced materially, the average for the months of August and Sep-

tember, 1927, being 6 or 7 per cent higher than during the corresponding months of the preceding year. Advance has been particularly conspicuous in the case of cotton as a result of a much reduced crop. As the prices of other commodities had meantime declined somewhat, the relative position of farm products has materially improved. On a pre-war base the index for them now stands quite as high as the average for nonagricultural articles.

The retail prices of food, which naturally show somewhat less sharp fluctuations than the wholesale prices of farm products, averaged 2 or 3 per cent lower in the fiscal year 1927 than in the preceding fiscal year, but appreciably higher than for several years back of that time. The general cost of living index compiled by the Department of Labor averaged practically the same in 1926–27 as in the preceding year. It may be noted that the Department of Labor has since the close of the fiscal year discontinued the publication of this index on the ground that it is not sufficiently representative of the true changes in the cost of living.

Price indexes

[Based upon calendar year 1913=100]

Item	Years ended June 30—				
	1923	1924	1925	1926	1927
Wholesale prices:					
General average	156	150	155	156	147
Farm products	139	140	153	152	138
Food	142	143	153	156	150
Cloths and clothing	193	194	189	184	171
Fuel and lighting	220	175	169	175	175
Metals and metal products	139	141	130	128	124
Building materials	188	182	174	174	170
Chemicals and drugs	129	129	133	133	126
House-furnishing goods	181	178	171	166	159
Miscellaneous	122	116	124	134	120
Retail prices:					
Food	143	146	150	162	158
General cost of living [1]	168	171	171	175½	174½

[1] Figures are averages of indexes for 3, 4, or 5 months distributed through the fiscal year, including in each case June of the previous year.

AGRICULTURE

The situation of the farmer has an important bearing on the general trend of industry and commerce. The crops harvested in the autumn of 1926, constituting the main factor in the agricultural situation of the fiscal year, were in the aggregate the largest produced in our history with the exceptions of the years 1915 and 1920. The output was approximately 2 per cent greater than in 1925. There was also a quantitative increase in the output of animal products. While

the value of animal products showed some gain, the lower prices of certain crops, notably of cotton, brought the total value of farm products in 1926–27 to a figure somewhat less than the year before, although higher than in any year from 1921–22 to 1924–25, inclusive. According to estimates of the Department of Agriculture the combined value of crops and animal products, deducting crops fed to animals, used for seed and waste, amounted to $12,080,000,000 as compared with $12,670,000,000 the year before.

The Department of Agriculture also makes a computation of the value of farm products by calendar years; this differs somewhat from that above mentioned in that the value of seed and of waste is not deducted. For each of the calendar years 1925 and 1926 the value of crops and animal products (excluding duplication of crops fed to livestock) was very close to $13,000,000,000. For the five years 1909 to 1913 the value similarly computed was $7,200,000,000.

It is true that the increase in agricultural production has been decidedly less marked than that in manufactured goods, both over a longer period of time and during the last few years. The demand for agricultural products, which are for the most part basic necessities, tends to grow little, if any, faster than population, while there is practically no limit to the demand for manufactured commodities; even if the need for one type is fully met, other still more highly elaborated articles come into use. New types are continually being devised along with advancing living standards.

Athough the crops of 1926 as a whole were larger than those of 1925 there was a decided falling off in corn, oats, and barley, this being more than offset by the increase in wheat, the crop of which in 1925 had been abnormally low, and in cotton.

The latest estimates of crop production in 1927 indicate some decline in combined output as compared with 1926. Wheat production increased somewhat but corn and oats show further decrease even from the low figures of 1926; the falling off in the number of horses, both on farms and in cities, has been in part responsible for the downward tendency in these two crops. The most conspicuous change from 1926 is the decided reduction in the cotton crop, resulting partly from a decline of about one-sixth in acreage, and partly from a lower yield per acre. The great Mississippi floods only in small part account for this change. On the basis of the higher prices of a number of the crops prevailing at the present time as compared with a year ago, it seems likely that the total value of the crops harvested in 1927 will materially exceed that in 1926. At present prices the reduced cotton crop, for example, would be worth more than the record crop of 1926.

Estimated value of farm products

[Millions of dollars]

Year	Crops (gross)	Animal products	Crops fed to livestock	Total, excluding crops fed to livestock
1909–1913	6,341	3,701	2,840	7,202
1921–1925	9,706	6,012	3,895	11,823
1921	7,759	5,589	3,080	10,268
1922	9,430	5,651	3,870	11,211
1923	10,401	6,271	4,290	12,382
1924	10,770	5,902	4,453	12,219
1925	10,170	6,647	3,783	13,034
1926	9,266	7,300	3,581	12,985

BY CLASSES

[Millions of dollars]

Product	Value	
	1925	1926
Total crops	10,170	9,266
Cereals	3,917	3,687
Cotton and cottonseed	1,799	1,294
Fruits	668	666
Hay and forage	1,471	1,490
Vegetables	1,288	1,117
Other crops and farm-forest products	1,027	1,012
Total animal products	6,647	7,300
Animals raised	2,672	3,065
Dairy products	2,746	2,952
Poultry products	1,117	1,181
Other animal products	112	102
Deduct crop fed to livestock	3,783	3,581
Net total, all products	13,034	12,985

CONSTRUCTION

New construction undertaken in the fiscal year 1926–27, amounting to some seven billion dollars in value, constituted a powerful factor in maintaining general business activity and prosperity. The physical volume of construction during this and the preceding year has much exceeded that even of the highly active years preceding and that customary before the war. The activity was high throughout the entire fiscal year.

The value of contracts awarded was approximately the same in 1926–27 as in 1925–26, and exceeded the average for the two years ending June 30, 1925, by no less than 37 per cent. The floor space

of buildings reported in these contracts was somewhat less than in 1925–26. This does not indicate a decrease in the volume of construction of corresponding measure. The buildings erected in 1926–27 appear to have been of types involving more expensive features per unit of area than the year before, and there was a marked increase in contracts for roads and other public works not in the form of building, whereas there was some decline in the value of contracts for buildings.

Retail prices of materials for a frame house, according to the index number computed by the Department of Commerce, and the general index of wholesale prices of building materials both declined during the year and are now lower than at any time since 1922. The averages of these indexes were slightly lower in 1926–27 than the year before and the lowest in five years.

The seasonal fluctuations in building and other construction operations have been decidedly less marked in the last three or four years than previously. Contractors, the owners of buildings, and other groups connected with construction have put forth serious efforts to keep building activity more nearly even throughout the year, and have had the active cooperation of this department in achieving tangible results. As a consequence, building-trades workers have enjoyed more stable employment, and at the same time the costs of construction to the public have undoubtedly been lower than would otherwise have been possible.

The high activity of residential construction in recent years is due not merely to the needs of expanding population but to the demand for better homes which comes with the general advance in living standards. During the past six years a substantial proportion of the residential construction has been of houses of moderate size and cost to supply the demands of receivers of moderate incomes who have found themselves able to afford better quarters. There is still need of improvement in the methods of financing home construction, especially for families of moderate or small incomes. A tendency toward lower interest rates on mortgages is, however, discernible in harmony with a general lowering of interest resulting from the large accumulation of capital.

The fiscal year 1926–27 witnessed a continuation of the relatively large program of construction of industrial, commercial, and public buildings. The advance in the character of buildings of this type—their greater cost, permanence, convenience, and attractiveness—is a conspicuous feature. There has been nothing to suggest extravagant expansion of industrial plants such as characterized the immediate postwar boom.

Construction statistics

Item	Years ended June 30—				
	1923	1924	1925	1926	1927
Indexes of volume of business 1919=100:					
Contracts awarded, value	136	143	164	210	210
Contracts awarded, volume floor space [1]	107	109	111	143	127
Cement shipments	152	158	178	183	191
Lumber production	117	121	120	125	112
Price indexes 1913=100:					
Frame-house materials, retail	198	206	198	195	192
Building material prices, wholesale	188	182	174	174	169

[1] Does not include floor space for public works and utilities.

TRANSPORTATION

During the last two fiscal years a conspicuous increase has occurred in the volume of railroad freight traffic, even as compared with the high figures for the fiscal years 1924 and 1925. The ton-mileage of freight in 1925–26 was about 8 per cent greater than the year before, and 1926–27 showed a further increase of about 5½ per cent. This gain in traffic was accomplished with an insignificant addition to the number of employees, a fact indicating the continued advance in the efficiency of the railways which has been going on since the close of the war. The increase in the volume of freight traffic has, in the absence of any significant changes in freight rates, served to add to the operating revenues of the railways and to increase their net operating income. Total operating revenues in 1926–27 exceeded the record figures of the preceding year by nearly 2 per cent, and there was a slight increase also in net operating income, which was thus the highest ever reported.

The increased prosperity of the railways in the last few years has gone hand in hand with steady improvement in the services rendered to the public. The chronic car shortages of former years have been overcome. The proportion of rolling equipment in bad order, both cars and locomotives, has been greatly cut down; in this respect the fiscal year 1926–27 marked the most satisfactory situation reported for many years. The tonnage per train has been increased; the average train in 1926–27 carried 786 tons of freight as compared with 656 in 1922. More important still from the standpoint of the general public welfare, delays in the movement of traffic have been greatly reduced. The expedition of railway service has reacted favorably upon the entire economic structure. It is estimated that the rapidity of freight transportation is now from 30 to 40 per cent greater than at the close of the war.

The improvement in railway service has resulted to a great degree from the efforts of the railway companies themselves, but an important auxiliary factor has been the cooperation of shippers and receivers of merchandise. The regional advisory boards of the American Railway Association, comprising representatives of producers and distributors, have served an important purpose. The organization of the system was carried to completion last year. Through the cooperation of these boards transportation needs have been analyzed and anticipated, car requirements estimated in advance, the loading of cars made heavier, and delays in loading and unloading cut down.

Operating statistics of Class 1 Railways

Item	Years ended June 30—					
	1922	1923	1924	1925	1926	1927
Freight ton-mileage (millions)	351,536	431,035	436,737	437,387	470,783	495,477
Carloads of all commodities (thousands)	40,658	47,193	48,992	49,678	51,905	53,627
Net tons per train	656	704	706	731	752	786
Net tons per loaded car	26.8	27.7	27.2	27.0	27.0	27.6
Average daily car surplus	272,756	36,399	187,554	252,410	218,779	213,154
Average daily car shortage	2,410	74,589	4,793	295	435	287
Bad-order cars, average	339,369	241,218	170,546	194,519	172,252	144,668
Bad-order locomotives, average	15,764	16,089	10,838	11,514	10,478	9,302
Number of employees	1,643,000	1,770,000	1,850,000	1,765,000	1,782,733	1,798,495
Total operating revenues (thousands of dollars)	5,508,169	6,104,274	6,120,646	6,011,864	6,325,158	6,442,387
Net operating income (thousands of dollars)	818,345	873,777	924,674	1,033,766	1,194,832	1,209,535

Motor transport.—The rapid increase in the use of motor trucks and motor busses in conjunction with older forms of transport has been remarkable, and this increase reflects to a large degree the rapidly changing conditions in modern methods of transportation and the progress made in highway surfacing.

Seventy-two railroads now use trucks to supplement regular shipping service—46 in terminal operations, 15 in the form of store-door delivery, and 11 to replace local freight trains. On January 1, 1927, railways had more than 225 trucks operating, the route mileage being 4,226. Competing services had 43,207 trucks covering 607,029 route-miles. Registration of all trucks in the United States was 2,764,222, compared with 2,432,017 the previous year.

Sixty steam railroads have 1,253 busses in operation, covering 11,440 route-miles, while there are 19,099 busses operated in competition with railroads, the route mileage being 334,522. Electric railroads in 1927 were using 7,284 busses, compared with 5,150 the previous year. Common-carrier bus-route mileage increased from

232,340 in 1926 to 270,068 miles this year. The total number of busses in operation increased from 69,425 to 80,040 during the year.

Ocean shipping.—Noteworthy encouragement prevails in ocean shipping throughout the world. Basicly, the industry has made substantial progress toward stability. The volume of oversea trade has increased slowly but steadily and only a small amount of idle tonnage remains out of employment.

Idle tonnage in the leading maritime countries of the world reached a new low postwar level and totaled only 3,968,000 gross tons at the end of July, 1927, or 35 per cent less than a year earlier. The decrease in idle tonnage in the United States amounted to 853,000 tons or 22½ per cent. Shipping in existence throughout the world, including only seagoing steel and iron steam and motor vessels of 100 gross tons and over, aggregated 59,612,000 gross tons, an increase of 1 per cent over that of the previous year. In contrast with the general trend there was a reduction in the fleet of the United States amounting to 180,000 tons or about 2 per cent.

Shipping under the American flag, documented for the foreign trade, declined by 11 per cent, but that documented for the coasting and Lake trade increased by 7 per cent. American vessels carried 31 per cent of the tonnage of our ocean-borne foreign trade in the calendar year 1926 as against 37 per cent in the preceding year. This drop, however, was largely the result of the heavy shipments of coal to Great Britain following the British coal strike; such shipments, naturally, were carried by tramps, relatively few of which are under the American flag.

The outstanding feature in shipbuilding during the year was the growth in the construction of motor vessels. At the close of June, 1927, the tonnage of such vessels being built throughout the world even exceeded the tonnage of steam vessels. In the United States, however, the reverse was true; motor vessels represented only 20 per cent of the total.

BANKING AND FINANCE

From the banking point of view the fiscal year, like the calendar year, was one of sound but uneventful growth, with ample money at low and stable rates. The rate of growth during the fiscal year seems, however, to have been somewhat slower than during the previous year. There was actually a perceptible degree of what would be termed "deflation," were our banks not already on a thoroughly sound basis. Money in circulation diminished by nearly 2 per cent, deposits grew about twice as fast as loans, reserve ratios rose, and time deposits grew more rapidly than demand deposits.

During the fiscal year deposits of all banks in the United States, except the 12 Federal reserve banks and a very few private banks not reporting, increased from $49,695,000,000 to $51,612,000,000, or 3.8 per cent. The corresponding increase in the previous fiscal year was 4.4 per cent. Such large absolute growth in the deposits of American banks, nearly two billion in a year, is noteworthy. In view of the lower price level of the later year, the real rate of growth in deposits was even greater than indicated.

Loans by "all banks" increased from $35,965,000,000 to $37,131,000,000, or 3.2 per cent; the corresponding increase during 1925–26 was 6.8 per cent. In rough figures, deposits increased by nearly two billions, while loans increased only about one billion. The absolute increase in loans was $1,166,000,000; of this amount half, or $553,000,000, is known to have been due to the increase in brokers' loans. The stock exchanges thus obtained about half of the additional bank credit used by the country.

The total resources of all member banks of the Federal reserve system represent over three-fifths of the aggregate of all banks of the country. As detailed periodic statistics on these banks are available, this group best serves to illustrate most of the developments in American banking. The decrease in the number of banks from 9,375 to 9,099 during the fiscal year, together with a 6 per cent increase in total capital and surplus, shows the tendency toward fewer and larger banks. Another strong tendency in American banking in recent years is observed in a further rise in the ratio of time deposits to demand deposits, from 64.3 per cent to 68.8 per cent. The ratio of total investments to total loans reveals a negligible decrease in the fluidity of American banking assets; that ratio rose from 41.0 per cent to 42.4 per cent. The absolute increase in investments, however, was only about half the absolute increase in total capital stock and surplus plus time deposits.

The absolute growth of American business activity is seen in the increase in the debits to individual bank accounts in 141 selected cities from 531 billions in 1924–25 and 597 billions in 1925–26 to 630 billions in 1926–27, a new record. But this absolute increase, enormous as it appears, was only half the absolute increase of 1925–26 over 1924–25.

The already vast reservoir of credit available through the Federal reserve banks was actually increased during the fiscal year. The reserve ratio began the fiscal year at 75.3 and ended it (June 29) at 77.6.

Money rates were stable. The discount rate of 11 of the reserve banks was 4 per cent throughout the fiscal year; the New York Reserve Bank rate, also, was 4 per cent on and after August 13, 1926. Only the Netherlands and Switzerland had lower central

bank rates. Open-market rates at New York on prime bankers' acceptances ranged between 3¼ and 3⅞ per cent; and even call loans (monthly averages) ranged usually between 4.03 and 4.75 per cent, the highest monthly average being that of December, 5.16 per cent. Prime commercial paper (4 to 6 months) ranged between 4¼ and 4½ per cent during 10 months of the fiscal year.

Foreign underwriting by Americans during the fiscal year exceeded that of any corresponding period in the history of the United States. The total par value of foreign capital securities publicly offered in the United States during 1926–27 was $1,511,000,000; during the two preceding fiscal years the average amount floated was $1,351,000,000. Foreign capital securities privately taken (not publicly offered), plus new direct investments abroad, probably raised the total to $1,850,000,000 for the year. Our net growth as a creditor nation was perhaps only about a third as great. The numerous important deductions from the gross figure of $1,850,000,000, include: Refunding, bond-redemption and sinking-fund payments to Americans by foreigners, resale to foreigners of foreign securities and direct investments abroad previously acquired by Americans, new investments in the United States by foreigners, etc.

Financial reconstruction abroad continued to be, on the whole, encouraging. On October 25, Belgium adopted the gold standard with a new unit of currency, the belga, worth $0.139. The fluctuations of French and Italian currencies seem now to be held within narrow limits. India formally adopted a new "gold-bullion" standard, with the rupee valued at 1s. 6d. On the other hand, early in the fiscal year, the silver exchanges sank badly; and in the spring Japan suffered a serious banking panic.

FOREIGN TRADE

The value of exports during the fiscal year 1926–27 was greater than in any other fiscal year since 1920–21, and when account is taken of the much lower price level, as compared with the war-years trade, was the largest in our history. The increase in dollar value of domestic exports as compared with 1925–26 was about 4½ per cent but prices were lower and the quantitative increase was in the neighborhood of 12 per cent. The decline in average prices of export commodities was in considerable part due to the sharp fall in cotton, but prices of many other exports showed more or less decrease.

The value of imports was about 5 per cent less during the last fiscal year than the year before, but here again a fall in prices occurred, after allowing for which there was a quantitative increase of between 3 and 4 per cent, even above the figures for 1925–26 which in turn had much exceeded those for any preceding fiscal year. The index of import prices was especially affected by the drop in the price of

rubber from the altogether excessive figures of the fall and winter of 1925–26.

The exports to all the continents and great trade regions of the world were greater in the last fiscal year than the year before except for a slight decrease in the value of sales to Latin America, a decline probably less than that in the prices of the commodities sold. The less favorable figures for Latin America were due largely to the relatively low price of sugar, reducing the buying power of Cuba, and to disturbed conditions in Mexico. The increase in the dollar value of sales to Europe is particularly notable in view of the decline in the price of cotton and various other commodities which bulk large in the trade with that continent.

In dollar value the imports from all the continents and great trade regions except northern North America (Canada and Newfoundland) were less in 1926–27 than the year before, but the change was insignificant in the case of Europe and Latin America, and in the case of Asia, Oceania, and Africa was largely if not wholly due to the lower prices of certain major imports from those regions.

The excess of exports over imports (the so-called "favorable balance of merchandise trade") in 1926–27 was $716,000,000, a very much greater figure than that of the year before but somewhat greater than the average of the five fiscal years 1922–1926. In part payment for this balance there was a net import of gold of $148,000,000. However, the other factors in our international balance of accounts are of vast and increasing importance, and undue significance is not to be attached to the balances in the movement of merchandise and of gold alone. As in other recent years, 1926–27 witnessed the great purchase of foreign bonds and other investments for which exports must pay. There was also heavy tourist travel and a large volume of immigrant remittances. On the other hand, each year shows a greater income from previous investments abroad, and such income, of course, constitutes one of the means for paying for merchandise imports.

Foreign trade of the United States

[Millions of dollars]

	Years ended June 30—					Per cent change, 1927 from 1926
	1910–1914	1924	1925	1926	1927	
Exports, merchandise	2,166	4,312	4,865	4,753	4,968	+4.5
Imports, merchandise	1,689	3,554	3,824	4,465	4,253	−4.7
Excess of exports (+) or of imports (−):						
Merchandise	+477	+758	+1,040	+289	+716	
Gold	+17	−407	+115	−97	−148	
Silver	+20	+19	+37	+29	+21	
Quantitative index eliminating the effect of price variations (1913=100):						
Domestic exports	89	122½	133½	137	153	+11.7
Imports	94	158½	161	170	176	+3.5

FOREIGN TRADE

GENERAL PROGRESS AND TENDENCIES

[By JULIUS KLEIN, Director, and E. DANA DURAND, Chief of Division of Statistical Research, Bureau of Foreign and Domestic Commerce]

The steady expansion of the foreign trade of the United States, the promotion of which is one of the principal functions of the Department of Commerce, must furnish ground for satisfaction to all classes in the community. Successful and growing international trade is a primary national function, both to find markets for surplus production and to furnish the means to exchange for those commodities which we do not ourselves produce and upon which our whole economic life and comfort depend.

It is true that the United States is exceptionally self-sufficing. Possessed of a great variety of resources and a still wider range of manufacturing industries, it needs to import a smaller proportion of its consumption than most countries of living standards in any way comparable with our own. So, too, our industry finds within our own borders the larger proportion of its market. Nevertheless, foreign trade is a highly important element in our national well-being. Export makes it possible to use our resources and energy to greater advantage; by widening the range of markets it gives to industry greater stability in output and thereby makes employment more secure. From the other side, importation of certain commodities which we can not produce is essential to the maintenance of our standards of living. We could not well do without such things as rubber, tin, nickel, silk, and certain other textile fibers. Our own production is not sufficient for our requirements of wool, hides and skins, and paper, of which we consume more than all other countries of the world combined. Our enjoyment of life would be much curtailed without such foreign foodstuffs as coffee, tea, cocoa, and tropical fruits and nuts. Obviously, if we are to import we must export.

The energy of American business men, with the aid of the Government, has brought great success in finding foreign markets. Our export trade has steadily grown in the face of the reduction in buying power of many countries of the world resulting from a war of unprecedented magnitude. The value of our exports in 1926–27 was more than two and one-fourth times greater than the average for the pre-war years 1910–1914. Even after allowing for the lower

buying power of money, they were nearly 70 per cent greater than before the war. The quantitative increase as compared with 1921–22 has been more than 30 per cent. Imports have increased even more than exports; in dollar value they were last year more than two and one-half times larger than the pre-war average and in quantitative terms nearly 90 per cent larger.

Although Europe is steadily recovering from the shock of the war and is rapidly expanding its exports as compared with the extremely low figures of the war and immediate postwar years, our foreign trade position compares more than favorably with that of most other countries. Adjusted for change in the buying power of money, exports from the United States in the calendar year 1926 were about 45 per cent greater than in 1913. Similarly adjusted the exports of all the rest of the world were only about equal to their pre-war volume, while the exports of Europe showed a decrease as compared with 1913 of about 20 per cent. American foreign trade, exports and imports combined, represented 11 per cent of the world's total trade in 1913 and 16 per cent at the present time.

The expansion of the foreign trade of the United States has been of benefit not only to this country but to the rest of the world. It is not true, as sometimes supposed, that our exports have expanded at the expense of the trade of competing countries. The growth of our exports has been a normal growth, merely continuing that which took place before the war. It reflects the general progress of our industry, and it represents our proportion of growing world demand. The rapid growth of our imports, outstripping that of exports, has furnished markets of inestimable value to other countries throughout the world.

Despite the expansion of our own manufactures we are importing more manufactured goods from Europe itself than ever before. More important still is the effect of the rapid increase in our foreign purchases of foodstuffs and raw materials. This country has filled in large part the void in demand resulting from the reduced income of Europe. Our purchases have given to the countries of Latin America, Asia, and Africa a buying power for manufactured goods which they would not otherwise have possessed. While part of that added buying power has gone to increase the imports of these countries from the United States, a large part has gone into purchases from Europe.

The war forced in immense export of agricultural products from the United States in contrast with the gradual decline in such exportation during the first 10 or 15 years of this century. When peace came foreign sales of agricultural products were bound to fall, with the recovery of European agriculture and the roepening of commerce

with countries which had been largely isolated before the war. It was essential, therefore, to the maintenance of our standards of living that we should increase the exports of manufactured goods in order to pay for the ever-increasing imports of foodstuffs and raw materials. On the other hand, by building up employment at home we have increased our domestic demand for agricultural products.

The task of increasing our exports of manufactured goods has been met partly by reduction of costs and increase of output per man, as more fully set forth in another section of this report. In part it has been met by greater attention to foreign marketing on the part of our business men, our merchants, and the Government itself. The success achieved is no less than extraordinary. Our exports of finished and partly finished manufactures in the fiscal year just closed amounted to no less than $2,670,000,000,000. This was an increase of 168 per cent over the pre-war average and of 65 per cent over the year 1921–22. The rate of growth of exports of finished manufactures, which are more competitive than the partly finished, as compared with pre-war figures, has been even more rapid. Finished manufactures represented 31 per cent of our exports from 1910 to 1914 and 41 per cent in 1926–27.

There is little doubt that manufactured goods will continue to gain in relative importance in our export trade. The growth of population in our own country will continue to call for the consumption at home of a larger and larger proportion of foodstuffs and raw materials produced by our farms. World demand for agricultural products is limited, since these are chiefly necessities; the demand for manufactured products is not so limited; it grows with every increase in buying power and standards of living. Just as manufactured products constitute year by year a larger proportion of our own production and consumption, so do they naturally of our exports to other countries. The expansion of manufactured goods, whether for domestic consumption or export, increases the demand for the farmer's products and furnishes the means for higher standards of living of the agricultural population.

The Department of Commerce also continues its efforts to promote the export of farm products. New markets have been sought out and new uses developed which have served to mitigate the postwar shrinkage in foreign demand. Despite the decline in the proportion which agricultural products form of our exports, they are much larger in absolute quantity at present than before the war. During the calendar year 1926 the value of agricultural exports was more than 75 per cent greater than the 1910–1914 average. Allowing for the higher price level, the increase was in the neighborhood of 20 per cent.

Growth of foreign trade of the United States

[Millions of dollars]

	Years ended June 30—					Per cent increase 1927 over—	
	1910–1914 average	1922	1925	1926	1927	1910–1914	1922
EXPORTS							
Total (domestic and foreign)	2,166	3,771	4,865	4,753	4,968	129	32
To—							
Europe	1,350	2,068	2,660	2,334	2,397	77	16
All other, total	816	1,704	2,205	2,420	2,572	215	51
Canada and Newfoundland	320	551	658	708	797	149	45
Latin America	302	536	845	879	869	187	62
Asia	121	480	458	537	584	382	22
Oceania	48	84	167	201	216	353	158
Africa	25	52	77	94	106	330	105
Total exports of domestic merchandise	2,130	3,700	4,778	4,653	4,868	128	32
Foodstuffs	421	1,144	1,061	780	877	108	−23
Raw materials	713	933	1,401	1,301	1,321	85	42
Semimanufactures	342	412	646	635	694	103	68
Finished manufactures	654	1,211	1,670	1,937	1,976	202	63
IMPORTS							
Total	1,689	2,608	3,824	4,465	4,253	152	63
From—							
Europe	836	831	1,171	1,275	1,268	52	53
All other, total	853	1,778	2,654	3,190	2,985	250	68
Canada and Newfoundland	119	310	411	476	486	310	57
Latin America	435	679	1,044	1,052	1,050	141	55
Asia	259	705	1,048	1,492	1,305	405	85
Oceania	17	31	65	71	59	242	89
Africa	23	52	84	99	86	282	65
Foodstuffs	398	635	903	930	969	144	53
Raw materials	595	927	1,452	1,905	1,651	177	78
Semimanufactures	307	407	701	796	759	147	87
Finished manufactures	389	639	767	834	874	125	37
QUANTITATIVE INDEXES							
Growth of trade, eliminating price changes (1913=100):							
Domestic exports	89	116	133½	137	153	+72	+12
Imports	94	137	161	170	176	+87	+4

As might be expected, our exports to those parts of the world which are little developed in manufacturing industry have increased more rapidly than our exports to Europe, which takes from us chiefly foodstuffs and raw materials. The value of our exports to Europe in 1926–27 was 77 per cent greater than the pre-war average

(1910–1914). Taking account of the change in prices this represents an increase of perhaps 35 or 40 per cent. Our exports to all other parts of the world taken together increased during the same period by 215 per cent in value, and by 125 to 150 per cent in quantity. Europe took five-eighths (62.3 per cent) of our total exports before the war and less than half (48.2 per cent) in 1926–27. Most remarkable has been the expansion of our sales in Asia, Oceania, and Africa. To each of these continents the value of our exports in 1926 was between four and five times greater than before the war.

Even since 1921–22 we have rapidly increased our sales to practically all non-European countries, in the face of the marked recovery of Europe's production and export capacity. With prices on a somewhat lower level our exports to the entire world, apart from Europe, were 51 per cent greater in value in 1926–27 than six years before. Apart from Europe, Asia is the only continent to which our exports during this period increased by less than 45 per cent; the slower growth in the case of Asia is due largely to the exceptional conditions in Japan and especially in China. It is encouraging to observe, however, that our sales to Asia have increased very materially in the last two years.

There is every reason to believe that American export trade will continue to grow along with the expansion of our production. The causes at work are such as may well be expected to continue; they are, moreover, cumulative in their effect. These causes were set forth in an address of Secretary Hoover which was quoted in the section on "Foreign trade" in the last annual report of the department. The facts given in the section of the present report dealing with the "Progress of national efficiency" have an obvious bearing upon the future of our trade.

Not only is the United States likely to increase its capacity to produce and to maintain its ability to compete with other manufacturing countries in world markets, but there is also reason to anticipate that world demand for goods will expand, provided always that peace is maintained. The same causes which are tending to build up productive capacity and advance living standards in the United States are at work all over the world. The progress of the newer and more backward countries is hastened by the investment of capital from the older and wealthier lands and by the participation of foreign experts and business managers. Advance in living standards brings with it some increase in the consumption of foodstuffs and the more necessary raw materials but it tends far more strongly still to increase consumption of the more elaborated goods. It is noteworthy that even the development of manufacturing industry in a given country does not check its import of manufactured goods but rather adds to it.

The fear has sometimes been expressed that the recovery of Europe would prevent further growth of our foreign trade, especially in manufactures. Experience of recent years shows that this fear is not well founded. Europe has been rapidly recovering but our exports have grown apace. Europe itself is an important market for certain of our manufactures and recovery there increases the demand for them. Still more does advancing prosperity in Europe tend to strengthen our trade with non-European countries. As Europe becomes more able to take the products of Latin America, the Far East, and Africa, those regions become more able to buy manufactured goods both from us and from our competitors.

For decades past there has been vigorous competition in international commerce. That competition has not prevented the expansion of the trade of every country save so far as the war intervened. Competition will continue. Our producers and exporters must be on their mettle, but if they put forth proper effort, we shall be able to maintain our share of the steadily expanding commerce. In the broad view, the progress of every country of the world is of benefit to every other country.

PROGRESS IN NATIONAL EFFICIENCY

[By E. Dana Durand, Chief of Division of Statistical Research, Bureau of Foreign and Domestic Commerce]

There has been an extraordinary increase in the production of American industry during recent years, with a consequent corresponding advance in standards of living. This reflects not merely recovery from the dislocation caused by the war, nor from the low point of the postwar slump—it represents in large part an advance beyond the highest pre-war levels and marks a trend which we may well consider of a permanent character. The country may from time to time in the future suffer the depressions of the business cycle, but there is no reason to anticipate any continuing recession from the present general productivity of industry, and on the contrary much reason to believe that progressively higher levels will be attained.

Recent careful calculations made by the Department of Commerce with reference to the quantitative output (eliminating the effect of price changes) of the major branches of industry show an immense increase since the beginning of the century, a great part of which has taken place in the few years since the war. Between 1899 and 1925 the output of agricultural products increased about 47 per cent, that of mining about 248 per cent, and that of manufactures about 178 per cent, while the volume of railway service increased by 199 per cent. The weighted total for these four branches of industry shows an increase of 140 per cent for the quarter century. Meantime population had grown only about 55 per cent, so that per capita output rose also by about 55 per cent.

Even this figure does not measure fully the progress in production for the reason that the number of workers in these four branches has increased much less than the total working population, a relative shift having taken place into the mercantile, professional, and personal-service pursuits. The increase in efficiency of older industries has freed great numbers of persons to undertake new industries, and thus add new articles and services to the standard of living. The most familiar evidence of such a shift is the great number now employed in occupations connected with motor vehicles, quite apart from those manufacturing them. From two and one-half to three millions of persons—perhaps even more—are engaged in selling automobiles and automobile supplies, including gasoline, in repairing them, in constructing good roads, and in driving trucks, taxicabs, and the like. Far the greater part of this number represents an increase above any corresponding occupations in the days preceding the automobile.

Increase in production of major branches of industry

[Manufactures indexes are computed from data for 1899, 1919, and 1925; other data are based on averages of three years, with a few exceptions]

Period and branch	Number of workers		Index for end of period; beginning=100		
	Beginning of period	End of period	Number of workers	Output, quantity of goods or services	Output per worker
1898–1900 to 1924–1926:					
Agriculture	10,700,000	10,700,000	100	147	147
Mining	600,000	1,050,000	175	348	199
Manufactures	5,300,000	[1] 9,900,000	187	278	149
Railways	970,000	1,860,000	192	299	156
Total or weighted average	17,570,000	23,510,000	134	240	179
1918–1920 to 1924–1926:					
Agriculture	11,300,000	10,700,000	95	112½	118
Mining	1,050,000	1,050,000	100	127	127
Manufactures	10,670,000	[1] 9,770,000	91½	128½	140½
Railways	2,035,000	1,860,000	91½	100	109
Total or weighted average	25,055,000	23,380,000	93	120	129

[1] The two figures given for the number employed in manufactures in 1925 differ in order to make them comparable with the figures for 1899 and 1919, respectively, which were reported on a slightly different basis.

The progress in efficiency is brought into sharp relief by comparing the increase in the product of agriculture, mining, manufactures, and railways with the increase in the number of persons employed in these branches. The addition of 140 per cent to their output between 1899 and 1925 was achieved by adding only 34 per cent to the number of workers. This means a gain in production per worker amounting to nearly 80 per cent. The increase has been shared by all the major branches. It is scarcely less conspicuous in agriculture than in manufactures and railway transportation, while the higher gain in mining has been due almost solely to the extraordinary expansion of the petroleum industry, in which the value of product per person employed is exceptionally high. It may be noted that the increase in output per worker for the four branches combined is greater than for all but one of the individual branches. The reason is that there has been a relative shift of workers from agriculture to other fields in which the amount of capital and power employed is greater so that the output is higher than in farming.

Statistics for different periods indicate that during the first decade of the century there was a steady increase in output per worker in the four major branches of industry. The shift of vast numbers to new jobs during the war and the general dislocation resulting from it brought down the efficiency of manufacturing industry so that the increase in combined output of the four branches between 1909 and 1919 was less than from 1899 to 1909. On the other hand,

the combined output of goods and services in agriculture, mining, manufactures, and transportation during 1925 (some of the figures are averages for the three years 1924 to 1926) was 20 per cent greater than in 1919, the increase in population meanwhile being not more than 10 per cent. The average output per worker increased no less than 29 per cent during this short interval. The number of persons employed in these fields is not merely relatively but absolutely less at the present time than at the close of the World War. This is a change unprecedented in our history or in that of almost any country growing in population. The shift into other pursuits has been much more rapid than ever before. The decline in the number of employees in agriculture, mining, manufactures, and railway transport is far from being an indication of business depression or of lack of employment. It is due to the advance in income which enables the people to devote a larger share of effort to services of distribution and to professional and personal services, reflecting a higher standard of living. If the reduction in workers in these four branches had meant unemployment, the great gain in output would have been impossible, since it could not have found a market.

That the marked recent advance in production is only in smaller part due to the relatively low efficiency of 1919, or to recovery from the slump of 1921, is evidenced by the increase that has taken place even since 1923, itself a year of high prosperity and activity. Between 1923 and 1925, when the last census of manufactures was taken, the number of factory workers decreased 4½ per cent, while the output (always in terms of quantity, not value) increased about 6 per cent. The monthly index of production of major manufactured commodities shows still further advance down to the present time, while there has also been a further reduction in the number of factory employees. The statistics also prove that the railways have continued to date to gain in efficiency and no doubt the same is true in agriculture and mining.

The increase in production per worker during the past quarter century has taken place in the face of a decided reduction in working hours. On the average, working time per week in manufacturing industries is to-day about 11 per cent less than in 1909, the first year for which comprehensive data were collected. It is probable that since 1899 the average working day in all branches of industry considered together has been shortened fully 15 per cent. The workers have reaped double advantage from expanding output—by increase of their wage and by reduction in their hours of labor.

The causes of prosperity and progress.—The causes which have made for the rapid advance in American industry are fortunately of an enduring and cumulative character. The idea that our present high prosperity is the result of the World War is wholly without

foundation. The war cut down the efficiency of our industry besides wasting an important fraction of its product. The increase in exports during the war was far less than the Government expenditures on war. Marked as has been the gain in the last few years in our export of manufactures, which alone competes with Europe, it shows less increase over the immediate pre-war period than that in turn showed over the opening years of the century. Exports at the present time are not a larger proportion of our production than before the war. Export trade in any case represents barely 10 per cent of our production of movable commodities.

The true causes of the prosperity and economic progress of the United States are not difficult to discern. At the foundation lie the rich resources of the country, not taxed by an excessive population, and the energy and intelligence and attitude toward work of the producing population. In our earlier days advance was in considerable measure attributable to the opening up of new resources, but during the past quarter century this has not been a major influence. There have been some discoveries of minerals, notably of petroleum, but these have been largely offset by the using up of other resources; for example, of the more conveniently located forest reserves. The principal factors of the recent increase in productivity are what may be called human as distinguished from natural factors.

These basic causes of economic progress translate themselves into a number of more specific and directly working causes. Among these may be mentioned especially the advance in education, scientific research, and invention; the growing use of mechanical power, machinery, and other forms of capital; the larger scale of production; the conscious and concerted effort to eliminate waste and reduce costs; the high scale of wages, with consequent general high buying power; and the relative stability of prices, money, and credit.

Taking into account both the enrollment and the length of attendance, the amount of instruction in elementary and secondary schools has increased, relatively to the total number of children, over 90 per cent since 1890. Pupils in high schools represented 5½ per cent of the total number of children of high-school age in 1890, and 35 per cent in 1926. The proportion of young men and women attending colleges, universities, and professional schools was 1½ per cent in 1890 and 9 per cent in 1926. At the same time instruction has become more effective, more practical; it does more to develop thinking than formerly. Our colleges and universities, moreover, have expanded enormously in their research work. Their activity has been supplemented by that of industrial concerns, many of which in recent years have established well-equipped and well-manned technical laboratories in which systematic efforts are made to improve methods, invent machinery, and devise new products. Added to

advance in physical sciences and invention has been the marked expansion of economic and statistical research and application of the results.

An immense increase has taken place in the capital employed in American industry. On the average each wage earner in our mines is now aided by more than $10,000 of capital, each factory employee by more than $5,000, and each railway worker by more than $8,000. It has been roughly estimated that the annual savings in the United States amount to about ten billions of dollars or approximately one-ninth of the national income. New issues of capital securities alone totalled more than six billions of dollars in 1926.

The accummulation of capital is reflected in the great and increasing application of mechanical power. On the average each factory wage earner to-day is aided by 4.3 horsepower of prime movers, a figure about double that in 1900. A similar great increase has taken place in the power of locomotives as compared with the number of railway employees. On farms the decline in the number of horses and mules is more than offset by the larger employment of mechanical tractors; as a consequence the number of acres tilled per worker is steadily rising. The United States now consumes in fuel and water power the equivalent of from 7 to 8 tons of coal per capita annually, as against less than 5 tons at the beginning of the century. The increase would be much greater but for the marked improvements in economizing fuel. The increasing use of mechanical power means, of course, a correspondingly greater use of machinery. Moreover, the machines themselves have been made more efficient so that the growth of power equipment does not fully measure the gain in productive capacity of machinery.

One of the most profound modern tendencies is the swiftly expanding use of electric current both in the household and in industry. We are adding 10 or 12 per cent to the output of electricity every year. Approximately two-thirds of our factory machinery is now operated by electric motors as compared with 15 per cent 20 years ago. The electric stations are rapidly advancing in technical efficiency. The amount of fuel converted to coal units burned in fuel-using electric plants has fallen from about 3.2 pounds per kilowatt hour in 1919 to about 1.9 pounds in 1927. There is little doubt that three times as much current is obtained from a given quantity of fuel at the present time as 15 or 20 years ago.

Industrial units in the United States are much larger than anywhere else in the world and are steadily growing in size. Manufacturing plants with an annual output exceeding $1,000,000 each represent only about 5 per cent of the total number of establishments, but they contribute two-thirds of the total value of factory products. Adjusting for change in the buying power of money, the correspond-

ing proportion 20 years ago was only about 45 per cent. Large-scale production is particularly conducive to low costs where processes are repetitive. Specialized machinery is used in such "mass production," whereas with a smaller output it would be necessary to use machines designed for more general purposes and less adapted to the particular task. The workers likewise can develop highly specialized efficiency. The immense domestic market of the United States makes possible repetitive production in numbers of units far greater than are produced in plants abroad.

At the close of the World War prices of commodities fell sharply. Wages, however, were maintained. This situation put on employers unprecedented pressure to cut down costs in every direction possible. Individual business concerns, trade associations, research organizations, private and public, and universities have entered upon serious and concerted study of problems of production. One of the several important directions taken has been in the simplification of products. In scores of branches of industry agreements have been reached to cut out unnecessary sizes, shapes, and varieties of articles and to concentrate production on a limited number of standard types.

The high and advancing level of real wages has also served directly to advance the efficiency of industry. It has meant an immensely wide and even wider market for commodities, and this has tended greatly to lower unit costs. It has also made for good health and contentment on the part of the workers and thereby increased their productive capacity. There is little tendency to restrict output or to oppose labor-saving machinery and methods. Labor very generally recognizes that large product tends to high wages.

The evidence of advance in wages is clear. By dividing the total amount paid in wages by the average number of wage earners as reported by the census of manufactures, the average annual wage for 1925 is found to have been $1,280. This average is for both sexes, all ages, and all degrees of skill. Adjusting for changes in the buying power of money the figure was at least 35 per cent higher in 1925 than in 1914, and that in the face of a considerable shortening of the working day. Many more detailed statistics of wages and of earnings likewise demonstrate the marked recent advance.

A factor of importance in our recent economic progress has been the relative stability of prices. Since the sharp break following the post-armistice boom, the general index of wholesale prices has changed relatively little. The general downward tendency during the past two years has apparently been due largely to the greater volume of commodities to be bought and sold, an increase attributable to the progress in the efficiency of industry. The relative stability of prices contrasts strikingly with the wide, often enormous, varia-

tions from which most countries of Europe have suffered since the war. The abundance of new capital and the soundness of the currency and banking system have facilitated business by making available ample credit, both short term and long term, at low and fairly stable rates.

All these specific factors in the prosperity and progress of the United States, as well as the more basic factors of abundant natural resources and a capable population, are of such a character that we may well hope for continuance of our economic progress. Indeed, these favorable factors tend to work cumulatively; each forward step makes another forward step easier. The fact that our national income is already high makes it possible for us readily to add to our capital equipment and to improve educational standards and to carry further scientific and technical research.

ELIMINATION OF WASTE

The work of the department in cooperation with industry and commerce in the elimination of waste has continued through the year. The purpose and method of organization of this service, by which cooperation is undertaken only upon request of the industry concerned, has been so fully set out in previous reports as not to require repetition on this occasion. Some of the notable accomplishments during the year may be mentioned (the fuller statement of which will be found in bureau reports).

1. Simplified practice activities which have been initiated by the industries show for the year the following major tangible results:

Activities	As of July 1, 1926	As of July 1, 1927	Increase	Per cent increase
Simplified practice recommendations completed	57	74	17	30
Acceptances, by trade associations	686	898	212	30
Acceptances, by individual firms	2,775	6,676	4,001	140
Projects based on requests for cooperation	368	596	228	62
Adherence by resurveys, cases	3	18	15	----------
Percentage of volume of production	65	79	----------	14
Adherence, by industry's estimates, cases	1	4	3	----------
Percentage of volume of production	75	84	----------	9
Previously completed recommendations:				
Revised	3	12	9	----------
Reaffirmed	7	17	10	----------
Sales of printed recommendations	250,000	350,000	100,000	40

New recommendations completed during fiscal year	Varieties		Reduction	Per cent reduction
	Formerly	Now		
Solid section steel sash	42,877	2,244	40,633	95
Hospital and institutional textiles	575	26	549	95
Lumber stock for wire-bound boxes (lengths)	102	6	96	94
Plumbing fixtures, staple vitreous	441	58	383	87
Concrete reinforcement bars (grades of steel)	3	1	2	67
Razor blades (systems of packing)	2	1	1	50
Salt containers	35	19	16	46
Flash-light cases	25	14	11	44
Metallic cartridges	348	256	92	26
Insulators, porcelain (one piece)	272	249	23	9
White glazed tile and ceramic mosaic (unglazed)	----------	(1)	(1)	----------
Metal spools and reels	----------	6	----------	----------
Bolt and nut containers	----------	18	----------	----------
Spark plugs	----------	6	----------	----------
Piston ring oversizes	----------	6	----------	----------
Brake linings	----------	37	----------	----------
Roller bearings, taper	----------	172	----------	----------

[1] Indeterminate.

2. Wood utilization:

(*a*) Development of use of short-length, soft-wood lumber for construction and industrial purposes. Small-dimension stock cut ready for use (industrial). Lumber cut and graded in accordance with American Lumber Standards. Grade-marked lumber.

(*b*) Standardization of ply-wood sizes.

(*c*) Revision of Government specifications to conform as closely as possible to commercial practices.

(*d*) Development of smooth-sawing practice in order to eliminate dressing of yard, crating, and box lumber.

(*e*) Sawmill-machinery studies for the purpose of utilizing top logs and small timber.

(*f*) Promotion of the use of sawdust and wood flour.

(*g*) Survey of nonutilized wood in Virginia (part of national survey) with a view to developing by-products industries.

3. Completion of survey and release of report entitled "Atlas of Wholesale Grocery Territories" which outlines the logical trading areas around the principal wholesale centers.

4. Surveys of definite commercial regions which aim to form a chart by which the merchant can map out his operations with a minimum of waste.

5. Study of functional costs of distribution.

6. Expansion of special-inquiry service for the public on domestic commerce problems.

7. Successful conclusion of important work in domestic packing activities and the publication of eight bulletins on domestic packing, materially aiding in the reduction of loss in shipment.

8. Successful cooperation with regional advisory boards, composed of shippers and receivers, part of the work of which concerns car requirements, market studies, and more even distribution of commodities.

9. Continuation of the campaign for the elimination of waste and carelessness in the protection of American patents and trade-marks abroad, in compliance with the requirements of foreign tariff administration and consular regulations.

10. Results of automotive research applied in production and operation indicate enormous savings to the public in connection with brake lining, fuel, and tires.

11. Practical application of the results of research in utilization of surplus corn by the dextrose industry proved by the commercial production of 200,000,000 pounds of crystalline dextrose in 1926.

12. Practical use by the Treasury Department of paper for currency, developed in experimental mill, shows average life of new paper is 10 months as compared to 7 months for that formerly used.

13. Elimination of multiplicity of effort through enlargement of the department's contacts with local governments by continued cooperation of:

(*a*) The Advisory Committee on Building Codes.

(*b*) Advisory Committee on City Planning and Zoning.

(*c*) National Conference on Street and Highway Safety.

(*d*) Department aid extended in establishment of airport facilities.

14. Continued cooperation with the construction industries and related groups to promote more stable building activity and facilitate home ownership.

15. Aid to stability in business and employment through prompt collecting and disseminating of current business statistics.

16. Continued production of fish 3 or 4 inches long for repopulation of our waters, and further confirmation of the conviction that a very great loss occurs when smaller fish are liberated.

17. Research in utilization of by-products of the fishing industry and reduction of loss in merchandising fresh fish.

18. The culmination of years of salmon investigation in the formulation of a successful plan for protection of salmon fisheries.

19. The development of a movable steel tower and its use in triangulation in flat country, thereby reducing the cost of first-order triangulation by more than 25 per cent.

20. Perfection of an echo-sounding machine for measurement of water depths, applicable to both marine surveying and to use by the navigator to prevent shipping delays and give added protection.

21. Development and use of devices for the protection of persons and property engaged in air transportation.

22. Protection to life and property through licensing of pilots and registry of aircraft, comparable to the services established in the interest of water transportation many years ago.

23. Enlargement of area from which vital statistics are collected, thereby adding materially to the data available for studies on health preservation.

24. The collection of statistics for an experimental census of distribution in 17 cities.

25. Saving of products heretofore lost and utilization of low-grade ores otherwise unworkable, due to the improvement of mining, milling, and metallurgical practice.

26. Prevention of the waste of certain natural gases containing helium.

27. Reduction of waste in nonmetallic mineral industries through improved quarrying practice and utilization of material heretofore discarded.

28. The increase of the percentage of lump coal produced by the improvement of blasting practice.

INCREASE OF STANDARDS OF LIVING

[By W. M. STEUART, Director of the Census, and REUBEN B. SLEIGHT, Assistant to the Secretary]

Foregoing chapters have discussed some of the developments which have had as their results the increase in American living standards. The Nation's moral and intellectual advancement is very closely related to the economic factors governing the standard of living. A unit of measurement can not be easily applied to the first, but indexes of the latter, indicators of material progress, are readily computed. The following table shows representative gains during the period 1919 to 1926:

Indicators of material progress of the Nation, 1919–1926

Item	1919	1926	Remarks
Life insurance in force, total excluding fraternal....dollars..	369	712	Per capita.
Savings deposits in banks and trust companies.....do....	[1] 144	211	Do.
Assets of building and loan associations.....do....	20	[2] 48	Do.
Members of building and loan associations.....number..	41	85	Per 1,000 population.
Residential buildings constructed during year, floor space[3].....square feet..	3.4	5.4	Per capita.
Death rate.....number..	12.9	12.2	Per 1,000 population.
Deaths of infants under 1 year of age.....do....	87	73	Per 1,000 births.
Sugar consumed during year.....pounds..	84	117	Per capita.
Meat consumed during year.....do....	138	156	Do.
Butter consumed during year.....do....	15.4	16.7	Do.
Fruit, fresh, carried by railroads during year.....do....	[1] 125	134	Do.
Vegetables, fresh, carried by railroads during year....do....	[1] 41	48	Do.
Pupils in high schools, public and private, total...number..	20	35	Per 1,000 population.
Students in universities, colleges, and professional schools, total.....number..	4.3	7.0	Do.
Electrical household appliance manufactures during year, value.....cents..	37	55	Per capita.
Washing machines, domestic use, manufactures during year, value.....cents..	39	60	Do.
Electric refrigerators sold during year.....number..	(4)	2.1	Per 1,000 population.
Bathtubs sold during year.....do....	3.9	10.2	Do.
Furniture, new, carried by railroads during year.....tons..	[1] 7.0	8.4	Do.
Telephones, total.....number..	122	151	Do.
Radio receiving sets, sold during year.....do....	(4)	15	Do.
Silk, imports, during year.....pounds..	530	660	Do.
Motor vehicle registrations.....number..	72	189	Do.
Roads, rural, surfaced, total.....miles..	2.9	4.8	Do.
Tractors on farms.....number..	38	[2] 79	Per 1,000 farms.
Farms receiving electric service from central stations[3].....number..	[5] 30	56	Do.
Residence electric customers, total.....do....	76	135	Per 1,000 population.
Electric customers, all classes, total.....do....	94	166	Do.
Electricity generated during year, public utility plants.....kilowatt hours..	371	630	Per capita.

[1] 1920. [2] 1925. [3] 27 States. [4] Insignificant. [5] 1923.

Indicators of material progress of the Nation, 1919–1926—Continued

Item	1919	1926	Remarks
Electrical manufactures, all classes, during year, value ....dollars..	9.50	14.50	Per capita.
Power in factories, mines, and public utility electric plants, total....horsepower..	433	495	Per 1,000 population.
Developed water power, total....do....	72	100	Do.
Power in factories....do....	3.26	4.26	Per wage earner.
Railroads, revenue freight carried during year....ton-miles..	3,497	3,820	Per capita.
Copper, refined, consumption during year....pounds..	14.2	21.6	Do.
Pig iron, production during year....tons..	295	336	Per 1,000 population.
Steel ingots and castings, production during year....do....	330	412	Do.
Rolled-steel products, finished, production during year ....do....	239	303	Do.
Brick, common and face, production during year..M brick..	53	[1] 87	Do.
Cement, Portland, consumption during year....barrels..	740	1,227	Do.

[1] 1925.

PROGRESS IN DEVELOPMENT OF COMMERCIAL AVIATION

[By Wm. P. MacCracken, Jr., Assistant Secretary of Commerce for Aeronautics]

On July 1, 1926, the Department of Commerce was charged with a new responsibility assigned to it by the passage of the air commerce act of 1926, providing for the promotion and regulation of civil aeronautics.

The department was charged with establishing and maintaining civil airways, equipping them with intermediate landing fields, beacon lights, radio apparatus, and other aids to air navigation; establishing air-traffic rules; inspecting, licensing, and identifying aircraft; examining and licensing airmen; collecting and disseminating information pertaining to air commerce and the art of aeronautics; investigating and reporting causes of accidents; establishing aeronautical weather service; publishing airway maps; conducting aeronautical research; encouraging the establishment and maintenance of airports and providing for their rating; and in general fostering air commerce and the aircraft industry.

The department's first task was to organize its aeronautical activities and select the necessary personnel. These activities were assigned to five divisions, three of which were created in existing bureaus and two of which are functioning independently of any bureau, but all five divisions are under the Director of Aeronautics and the Assistant Secretary of Commerce provided for in the new act. The work of establishing, maintaining, and operating aids to air navigation was assigned to the Lighthouse Bureau, which established an airways division. The mapping of air routes was assigned to the Coast and Geodetic Survey, and a division of aeronautical research was set up in the Bureau of Standards. The other two divisions are known as the air regulations division and the air information division.

At the close of the fiscal year the personnel included an Assistant Secretary of Commerce for Aeronautics, a Director of Aeronautics, acting chief of the air information division, chief engineer of the airways division, medical director, a chief inspector and 15 aircraft and engine inspectors, 15 airway extension superintendents, and a director of aeronautical research. The total office personnel was 61, and the field personnel 161.

Congress had made available appropriations totaling $550,000 of which $300,000 was to be used for aids to air navigation and $250,000

for the remaining activities. During the fiscal year a portion of the 1928 appropriation was made immediately available, with the result that the total expenditures under the heading "Aids to air navigation" amounted to $584,510 and for "Aircraft in commerce" amounted to $250,000. Included in these expenditures is the purchase of four airplanes, and the program authorized the acquisition of six additional planes. The department also received six planes from the Post Office Department, and the temporary loan from time to time of aircraft from the Army and Navy.

During this period the airways division provided lighting facilities for 2,080 miles of airways, and prepared to take over at the beginning of the next fiscal year 2,041 miles of airways which had been lighted by the Post Office Department.

The air regulations division drafted, after a conference with manufacturers, operators, and other interested parties, the Air Commerce Regulations of 1926, which became effective December 31.

Unfortunately it was impossible during the remaining half of the fiscal year to secure applications for all aircraft then operating in the United States. However, there were received applications for 1,123 aircraft licenses, 288 aircraft-identification marks, 24 approved-type certificates, 1,812 pilots' licenses, and 1,626 mechanics' licenses. While it was necessary to permit a considerable number of aircraft to operate on temporary authority, it is essential that a sufficiently large force of inspectors be provided in the future to dispense with this practice.

The aeronautical research division devoted its energy to improving radio directional beacons and to two-way radio communication between the plane and the ground. At the close of the year this work had progressed to a point where the equipment was ready for installation on civil airways.

The first airways map was prepared and published by the Coast and Geodetic Survey, and plans were perfected for mapping additional routes.

The air information division collected and disseminated a vast amount of statistics and information pertaining to all lines of aeronautical activities, arranged for the appointment of the first aeronautical trade commissioner, and sponsored four nation-wide tours in the interest of promoting civil aeronautics.

The outstanding achievements in civil aeronautics for the year include the inauguration of scheduled commercial service over routes totaling 2,429 miles; the contracting by the Post Office Department of all postal operations between New York and San Francisco at prices varying from 50 to 75 per cent below the maximum allowed by the air mail contract law; the consummation of a contract between

the American Railway Express Co. and a group of 4 air transport operators providing for aerial express service on 5 routes totaling 4,459 miles; an increase in air-mail poundage of 80 per cent; the establishment of more than 100 airports; the holding of the first all-American aircraft display at Bolling Field, climaxed by the remarkable flight of Charles A. Lindbergh from New York to Paris, which was the first of a series of successful transoceanic flights by American civilian pilots using commercial aircraft and engines designed and built in the United States.

Statistics are not available showing the number of aircraft manufactured during the fiscal year, but the production for the last six months of the period exceeded the total production for the preceding calendar year. At the beginning of the fiscal year most of the manufacturers had some of their product in stock. By the close of the year the entire aircraft industry was unable to meet the demands of the public for equipment. Some of the factories were working in two and three shifts and there is every indication that this condition will exist well into the coming year.

On June 30, 1927, air-transport operators were serving 66 cities, with a total population of 20,038,075 and a total mileage of 8,396. In addition to the mileage now in operation the Post Office Department had contracted for air mail service over a distance of 763 miles, and there were pending advertisements for service on 1,557 miles and 825 miles proposed for advertisement. During the year three air-transport operators withdrew from the field, one operating between Philadelphia, Washington, and Norfolk, which service was inaugurated primarily as a part of the Sesquicentennial Exposition held at Philadelphia; one operating between Atlanta, Ga., and Miami, Fla.; and the other operating between Chicago, Ill., and St. Paul, Minn. Service on this latter line, however, was not interrupted, as a new contractor was ready to carry on the service at the expiration of the 45 days' notice required by the Post Office Department. It is contemplated that the Atlanta-Miami service will be resumed as soon as the New York-Atlanta line, now under contract, begins operation.

While the majority of the air-mail contractors sustained financial losses as a result of their operations for the entire fiscal year, during the last three months of the period the majority of them were making expenses, and several of them showed satisfactory profits. Aerial operations showed an increase both in number and volume of business. Most important is the fact that these enterprises are rapidly developing into profitable organizations with better equipment and more adequate air-port facilities. Several larger corporations acquired planes for use in delivering their products and expediting the travel of their executives. A number of airplane clubs have been organ-

ized and demands for equipment to be used in sport flying have showed a marked increase.

While the air commerce act left to the States the right to regulate intrastate and noncommercial operations, the tendency on the part of the great majority of State authorities has been to look to the Federal Government for this service rather than to undertake the function themselves. It is anticipated that practically all of the States will follow the example of those that already require a Federal license in order to fly within their borders.

The interest in civil aeronautics, particularly as it pertains to establishing municipal airports, expanding the air mail service, and in fact, in all forms of civilian flying has been so great that the department has found it difficult, and in some cases impossible, to meet the demands which have been placed upon it. In the brief period of 12 months the entire Nation has been aroused to the possibilities of civil aernautics. No longer does an inferiority complex impede aeronautical progress. There has been built a solid foundation upon which to achieve and maintain world supremacy in civil aeronautics.

CONDENSED REPORTS OF BUREAUS

ADMINISTRATIVE DIVISIONS OF THE OFFICE OF THE SECRETARY

DEPARTMENT OF COMMERCE,
OFFICE OF THE CHIEF CLERK,
Washington, July 1, 1927.

Hon. HERBERT HOOVER,
Secretary of Commerce.

DEAR MR. SECRETARY: In response to your request I furnish the following condensed report of the work of the various divisions of the Secretary's office during the past year:

The demands during the past year upon the various divisions, which are service units for the entire department, have been unusually heavy, but being manned by a competent and efficient staff, they have functioned in a most satisfactory manner.

The loyalty and cooperative spirit of the employees is reflected in the overtime work performed throughout the divisions of the Office of the Secretary, 61 employees having performed 445 days of overtime work.

Employees throughout the department cheerfully responded to the call for contributions in aid of the Mississippi River flood sufferers, the total contributions amounting to $2,431.47.

NEED FOR ADDITIONAL SPACE

Need for additional space to properly house the department's activities has been a continuing problem during the past year. To relieve the pressure in the Commerce Building it was necessary to move all of the Bureau of Navigation and two sections of the Bureau of Foreign and Domestic Commerce to Tempo Building No. 5, thus necessitating a further scattering of the activities of the department. The Commerce Building, the lease of which will expire in June, 1929, is still crowded beyond comfort or utility, and a further overflow will soon become necessary.

The department, exclusive of the Bureau of Standards, is housed in buildings at nine different locations throughout the city, as follows:

Building and location	Bureaus or offices housed
Commerce Building, Nineteenth and Pennsylvania Avenue NW.	Secretary's Office. Bureau of Foreign and Domestic Commerce (part). Radio Division. Division of Simplified Practice. Division of Building and Housing.
Hurley-Wright Building, Eighteenth and H Streets NW.	Bureau of Lighthouses. Bureau of Foreign and Domestic Commerce (part). Inter American High Commission.
Fisheries Building, Sixth and B Streets SW	Bureau of Fisheries.
Building D, Sixth and Missouri Avenue SW	Bureau of the Census.
Coast and Geodetic Survey, 205 New Jersey Avenue SE	Coast and Geodetic Survey.
Patent Office Building, Ninth and F Streets NW	Patent Office (part).
Old Land Office Building, Eighth and F Streets NW	Do.
Winder Building, Seventeenth and F Streets NW	Bureau of Mines.
Tempo Building No. 5, Twentieth and B Streets NW	Steamboat Inspection Service. Bureau of Navigation. Bureau of Foreign and Domestic Commerce (part).

Since the lease to the Commerce Building will expire June 30, 1929, a further problem of housing the department will then confront us.

INTERNATIONAL SESQUICENTENNIAL EXPOSITION

The department had a comprehensive exhibit at the International Sesquicentennial Exposition, Philadelphia, Pa., between July 12 and November 30, 1926. Each bureau was represented. The displays ranged from various microscopic pieces to ocean buoys and railroad cars. American business men gave generous aid, making possible a diversified and popular demonstration. Historic background was afforded by the Patent Office model display, as well as by ancient pieces in other bureau exhibits. The department's exhibit occupied 37,000 square feet of floor space in the Transportation Building and required a force of about 25 attendants. It is estimated that about one million persons visited the exhibit in the course of the Exposition. The Exposition made 24 awards to the department, including 1 grand prize, 14 medals of honor, 8 gold medals, and 1 silver medal.

COOPERATION WITH FEDERAL AGENCIES

The divisions of the Secretary's Office during the year assisted in effecting economies and improved methods of administration throughout the Government service by representation upon many coordinating boards and committees. The Chief Clerk is chairman of the Association of Chief Clerks of the Executive Departments, and a member of the executive committee, Board of Simplified Office Procedure. The chief of the appointment division is a member of the Association of Personnel Officers, Executive Departments and Independent Government Establishments, chairman of the departmental Classification Board and acts as classification officer for the department, and a member of the oral examining board of the

Bureau of Foreign and Domestic Commerce. The chief of the division of publications represents the department on the Permanent Conference on Printing, the first coordinating agency organized under the direction of the Bureau of the Budget, and is chairman of the executive committee of the Conference. The disbursing clerk represents the department on the Advisory Committee on Fiscal Accounting Forms and Procedure under the office of the Comptroller General. The chief of the division of supplies serves as chairman, departmental board on contracts and adjustments; chairman, auditing committee of financial clerk's record, Patent Office; chairman, board of survey of the department; department's representative, interdepartmental board of contracts and adjustments, Federal purchasing board and Federal real estate board. The traffic clerk serves as the department's representative on the Federal Traffic Board and chairman of the legislative committee of that board; member water freight committee, classification committee, accounting committee, and advisory committee, all of the Federal Traffic Board; and as member of a special committee of the Bureau of the Budget on travel regulations.

DISBURSING OFFICE

The itemized statement of the disbursements from the contingent fund of the department and the appropriation for "General expenses, Bureau of Standards," for the fiscal year ended June 30, 1927, required to be submitted to Congress by section 193 of the Revised Statutes of the United States (U. S. C. Title 5, sec. 104); the itemized statement of expenditures under all appropriations for propagation of food fishes during the fiscal year ended June 30, 1927, required by the act of Congress approved March 3, 1887 (24 Stat. 523, U. S. C. Title 16, sec. 744); and a statement showing travel on official business by officers and employees (other than special agents, inspectors, and employees who, in the discharge of their regular duties, are required to travel constantly) from Washington to points outside of the District of Columbia during the fiscal year ended June 30, 1927, as required by the act of Congress approved May 22, 1908 (35 Stat. 244, U. S. C. Title 5, sec. 105); and a statement showing typewriters, adding machines, etc., exchanged by this department during the fiscal year ended June 30, 1927, as required by section 5 of the act of March 4, 1915 (38 Stat. 1161, U. S. C. Title 41, sec. 26), will be transmitted to Congress in the usual form.

The table following shows the total amount of all appropriations for the various bureaus and services of the Department of Commerce for the fiscal year ended June 30, 1927:

Bureau	Annual appropriation acts	Deficiency act	Executive order	Special act
Office of the Secretary	$1,537,500.00	$252,500.00		
Bureau of Foreign and Domestic Commerce	3,263,357.00			
Bureau of the Census	1,974,000.00			
Steamboat Inspection Service	1,062,670.00			
Bureau of Navigation	312,100.00			$1,745.46
Bureau of Standards	2,090,385.00	50,000.00		
Coast and Geodetic Survey	2,341,670.00	7,300.00		
Bureau of Lighthouses	10,145,481.00	532,150.00		
Bureau of Fisheries	1,744,253.00	20,000.00		
Patent Office	2,722,300.00		$40.05	
Bureau of Mines	3,430,181.98	100,000.00	173.88	
Printing and binding	1,688,231.00	405,000.00		
Total	32,312,128.98	1,366,950.00	213.93	1,745.46

Bureau	Allotments by other departments	Total	Transferred to retirement fund	Net amount available for expenditure by this department
Office of the Secretary		$1,790,000.00		$1,790,000.00
Bureau of Foreign and Domestic Commerce		3,263,357.00		3,263,357.00
Bureau of the Census		1,974,000.00	$1,223.01	1,972,776.99
Steamboat Inspection Service		1,062,670.00		1,062,670.00
Bureau of Navigation		313,845.46	2,257.25	311,588.21
Bureau of Standards	$184,850.00	2,325,235.00	6,330.41	2,318,904.59
Coast and Geodetic Survey	4,200.00	2,353,170.00		2,353,170.00
Bureau of Lighthouses		10,677,631.00	1,190.19	10,676,440.81
Bureau of Fisheries		1,764,253.00	1,630.00	1,762,623.00
Patent Office		2,722,340.05		2,722,340.05
Bureau of Mines	325,000.00	3,855,355.86	10,328.52	3,845,027.34
Printing and binding		2,093,231.00		2,093,231.00
Total	514,050.00	34,195,088.37	22,959.38	34,172,128.99

The disbursements by the authorized disbursing officers of the department during the fiscal year ended June 30, 1927, arranged according to items of appropriation, are as follows:

Office of the Secretary:	
Contingent expenses, Department of Commerce, 1925	$52.60
Contingent expenses, Department of Commerce, 1926	51,617.46
Contingent expenses, Department of Commerce, 1927	234,380.75
Printing and binding, Department of Commerce, 1925	9,619.30
Printing and binding, Department of Commerce, 1926	169,719.26
Printing and binding, Department of Commerce, 1927	1,201,640.19
Printing and binding, Department of Commerce, 1926–27	30,000.00
Rent, Department of Commerce, 1926	5,583.33
Rent, Department of Commerce, 1927	63,516.08
Salaries, Office of the Secretary, 1925–26	9,677.84
Salaries, Office of the Secretary, 1927	231,558.59
Total	2,007,365.40
Bureau of Foreign and Domestic Commerce:	
Commercial attachés, 1925	91.97
Commercial attachés, 1926	7,026.60
Commercial attachés, 1927	326,778.34
Compiling foreign-trade statistics, 1926	20,467.87
Compiling foreign-trade statistics, 1927	305,061.71
District and cooperative office service, 1925	115.81
District and cooperative office service, 1926	16,349.29
District and cooperative office service, 1927	301,181.34
Domestic commerce, Department of Commerce, 1926	8,152.66
Domestic commerce, Department of Commerce, 1927	145,019.41
Enforcement of China trade act, 1925	1.50
Enforcement of China trade act, 1926	374.30
Enforcement of China trade act, 1927	19,546.02
Export industries, 1925	32.15
Export industries, 1926	32,163.50
Export industries, 1927	565,273.46
Investigating sources of crude rubber, 1925	45.09
Investigation of foreign-trade restrictions, 1926	1,753.89
Investigation of foreign-trade restrictions, 1927	32,247.10
Lists of foreign buyers, 1926	627.20
Lists of foreign buyers, 1927	17,562.82
Promoting commerce, Department of Commerce, 1925	36.86
Promoting commerce, Department of Commerce, 1926	16,786.94
Promoting commerce, Department of Commerce, 1927	447,725.38
Promoting commerce in the Far East, 1925	128.01
Promoting commerce in the Far East, 1926	14,011.76
Promoting commerce in the Far East, 1927	258,540.22
Promoting commerce, South and Central America, 1923	1,505.09

Bureau of Foreign and Domestic Commerce—Continued.	
Promoting commerce, South and Central America, 1925	$114. 26
Promoting commerce, South and Central America, 1926	8, 239. 34
Promoting commerce, South and Central America, 1927	310, 614. 48
Salaries, Foreign and Domestic Commerce, 1926	10, 880. 21
Salaries, Foreign and Domestic Commerce, 1927	235, 334. 79
Transportation of families and effects of officers and employees, 1925	89. 51
Transportation of families and effects of officers and employees, 1926	3, 989. 75
Transportation of families and effects of officers and employees, 1927	36, 156. 96
Total	3, 144, 025. 59
Bureau of Standards:	
Advisory Committee for Aeronautics (transfer to Commerce, Bureau of Standards, act Feb. 27, 1925), 1926	3, 394. 46
Advisory Committee for Aeronautics (transfer to Commerce, Bureau of Standards, act Apr. 29, 1926), 1927	29, 785. 57
Air Service, Army (War transfer to Commerce, Bureau of Standards, act of May 21, 1920), 1925	358. 19
Air Service, Army (War transfer to Commerce, Bureau of Standards, act of Feb. 27, 1925), 1926	2, 946. 96
Air Service, Army (War transfer to Commerce, Bureau of Standards, act Apr. 29, 1926), 1927	4, 903. 27
Automatic rifles (War transfer to Commerce, Bureau of Standards, act of Feb. 27, 1925), 1926–27	150. 60
Automatic rifles (War transfer to Commerce, Bureau of Standards, act of Apr. 29, 1926), 1927–28	1, 066. 01
Aviation, Navy (Navy transfer to Commerce, Bureau of Standards, act of Feb. 27, 1925), 1926	7, 222. 73
Aviation, Navy (Navy transfer to Commerce, Bureau of Standards, act of Apr. 29, 1926), 1927	65, 016. 30
Aviation, Navy (Navy transfer to Commerce, Bureau of Standards, act of May 21, 1920), 1925	1, 780. 70
Coast Guard (Treasury transfer to Commerce, Bureau of Standards, act of May 21, 1920), 1925	287. 50
Building for power plant	2, 116. 00
Color standardization, 1926	581. 73
Color standardization, 1927	7, 729. 59
Compensation of employees, Bureau of Engraving and Printing (Treasury transfer to Commerce, Bureau of Standards, act Feb. 27, 1925), 1926	227. 50
Compensation of employees, Bureau of Engraving and Printing (Treasury transfer to Commerce, Bureau of Standards, act Apr. 29, 1926), 1927	12, 432. 77
Conference on oil pollution of navigable waters (State transfer to Commerce, Bureau of Standards, act of Mar. 4, 1925), 1925–26	145. 49
Conference on oil pollution of navigable waters (State transfer to Commerce, Bureau of Standards, act of Mar. 4, 1925), 1925–1927	1, 911. 75
Construction and repairs, Bureau of Construction and Repair (Navy transfer to Commerce, Bureau of Standards, act of Feb. 27, 1925), 1926	1, 708. 82
Construction and repairs, Bureau of Construction and Repair (Navy transfer to Commerce, Bureau of Standards, act of Apr. 29, 1926), 1927	1, 557. 25
Engineering, Bureau of Engineering (Navy transfer to Commerce, act of May 21, 1920), 1925	882. 45
Engineering, Bureau of Engineering (Navy transfer to Commerce, act of Feb. 27, 1925), 1926	452. 22
Engineering, Bureau of Engineering (Navy transfer to Commerce, act of Apr. 29, 1926), 1927	1, 895. 76
Equipment, 1925	6, 493. 50
Equipment, 1926	6, 695. 90

Bureau of Standards—Continued.	
Equipment, 1927	$75, 185. 45
Export industries, Department of Commerce (transfer to Bureau of Standards, act of Feb. 27, 1925), 1926	288. 07
Field artillery, armament (War transfer to Commerce, Bureau of Standards, act of Apr. 29, 1926), 1927	3, 552. 76
Gauges, dies, and jigs for manufacture (War transfer to Commerce, Bureau of Standards, act of May 21, 1920), 1926	1, 160. 95
Gauges, dies, and jigs for manufacture (War transfer to Commerce, Bureau of Standards, act of May 21, 1920), 1927	2, 749. 96
Gauge standardization, 1926	3, 338. 83
Gauge standardization, 1927	35, 100. 45
General expenses, Bureau of Entomology (Agriculture transfer to Commerce, Bureau of Standards, act of Feb. 27, 1925), 1926	190. 93
General expenses, Bureau of Standards, 1925	707. 71
General expenses, Bureau of Standards, 1926	12, 197. 67
General expenses, Bureau of Standards, 1927	55, 877. 13
General expenses, Coast and Geodetic Survey (transfer to Bureau of Standards, act Feb. 27, 1925), 1925	1, 756. 67
General expenses, Lighthouse Service (transfer to Bureau of Standards, act of Feb. 27, 1925), 1926	848. 32
High-temperature investigations, 1926	514. 22
High-temperature investigations, 1927	7, 370. 27
Improvement and care of grounds, 1926	399. 50
Improvement and care of grounds, 1927	10, 532. 36
Incidental expenses of the Army (War transfer to Commerce, Bureau of Standards, act of May 21, 1920), 1923	26. 76
Incidental expenses of the Army (War transfer to Commerce, Bureau of Standards, act of May 28, 1924), 1925	119. 10
Incidental expenses of the Army (War transfer to Commerce, Bureau of Standards, act of Feb. 27, 1925), 1926	1, 886. 37
Incidental expenses of the Army (War transfer to Commerce, Bureau of Standards, act of Apr. 29, 1926), 1927	10, 017. 95
Industrial research, 1926	12, 899. 82
Industrial research, 1927	158, 531. 39
Investigation of automotive engines, 1926	3, 125. 61
Investigation of automotive engines, 1927	22, 283. 82
Investigation of clay products, 1926	2, 080. 15
Investigation of clay products, 1927	39, 812. 81
Investigation of fire-resisting properties, 1926	687. 70
Investigation of fire-resisting properties, 1927	23, 894. 76
Investigation of mine scales and cars, 1925	2, 703. 75
Investigation of mine scales and cars, 1926	969. 75
Investigation of mine scales and cars, 1927	10, 980. 72
Investigation of optical glass, 1926	1, 331. 98
Investigation of optical glass, 1927	17, 269. 11
Investigation of public utility standards, 1926	8, 168. 18
Investigation of public utility standards, 1927	88, 128. 88
Investigation of radioactive substances, 1926	409. 48
Investigation of radioactive substances, 1927	8, 370. 54
Investigation of textiles, etc., 1926	1, 977. 45
Investigation of textiles, etc., 1927	33, 101. 07
Metallurgical research, 1926	4, 265. 89
Metallurgical research, 1927	38, 362. 20
Master track scale and test car depot, 1927	135. 53
Ordnance and ordnance stores, Bureau of Ordnance (Navy transfer to Commerce, Bureau of Standards, act of May 21, 1920), 1925	244. 99
Ordnance and ordnance stores, Bureau of Ordnance (Navy transfer to Commerce, Bureau of Standards, act of May 21, 1920), 1926	1, 410. 35
Ordnance and ordnance stores, Bureau of Ordnance (Navy transfer to Commerce, Bureau of Standards, act of May 21, 1920), 1927	8, 108. 09
Ordnance stores, ammunition (War transfer to Commerce, Bureau of Standards, act of May 28, 1924), 1925–26	380. 03

Bureau of Standards—Continued.	
Ordnance stores, ammunition (War transfer to Commerce, Bureau of Standards, act of Apr. 29, 1926), 1926	$706. 67
Proving grounds, Army (War transfer to Commerce, Bureau of Standards, act of May 21, 1920), 1925	150. 00
Radio research, 1926	1, 549. 03
Radio research, 1927	43, 758. 05
Rope investigations, 1925	2. 73
Salaries, 1926	20, 937. 21
Salaries, 1927	516, 906. 43
Signal Service of the Army (War transfer to Commerce, Bureau of Standards, act of May 21, 1920), 1926	5, 000. 00
Signal Service of the Army (War transfer to Commerce, Bureau of Standards, act of Feb. 27, 1925), 1926	97. 57
Signal Service of the Army (War transfer to Commerce, Bureau of Standards, act of Apr. 29, 1926), 1927	1, 520. 36
Sound investigation, 1927	9, 464. 62
Standardization of equipment, 1925	15. 07
Standardization of equipment, 1926	9, 607. 05
Standardization of equipment, 1927	92, 662. 27
Standard materials, 1926	308. 75
Standard materials, 1927	9, 307. 36
Standardizing mechanical appliances, 1926	2, 535. 52
Standardizing mechanical appliances, 1927	24, 219. 36
Sugar standardization, 1926	2, 406. 22
Sugar standardization, 1927	33, 268. 14
Sugar standardization, 1926–27	21, 486. 99
Testing machines, 1926	2, 005. 71
Testing machines, 1927	32, 270. 06
Testing miscellaneous materials, 1926	3, 602. 49
Testing miscellaneous materials, 1927	37, 468. 47
Testing railroad scales, etc., 1925	20. 74
Testing railroad scales, etc., 1926	4, 352. 22
Testing railroad scales, etc., 1927	34, 754. 29
Testing structural materials, 1923	. 97
Testing structural materials, 1926	15, 890. 66
Testing structural materials, 1927	200, 447. 37
Washington-Alaska military cable and telegraph system (War transfer to Commerce, Bureau of Standards, act May 28, 1924), 1925–26	46. 32
Total	2, 001, 967. 20
Steamboat Inspection Service:	
Clerk hire, 1926	224. 65
Clerk hire, 1927	127, 668. 49
Contingent expenses, Steamboat Inspection Service, 1925	32. 34
Contingent expenses, Steamboat Inspection Service, 1926	25, 976. 17
Contingent expenses, Steamboat Inspection Service, 1927	113, 328. 26
Salaries, Office of Supervising Inspector General, 1926	1, 018. 09
Salaries, Office of Supervising Inspector General, 1927	23, 240. 08
Salaries, Steamboat Inspection Service, 1926	504. 56
Salaries, Steamboat Inspection Service, 1927	684, 205. 76
Total	976, 198. 40
Bureau of Navigation:	
Admeasurement of vessels, 1926	368. 39
Admeasurement of vessels, 1927	4, 064. 40
Clerk hire, shipping service, 1926	7, 260. 12
Clerk hire, shipping service, 1927	80, 776. 63
Contingent expenses, shipping service, 1925	4. 26
Contingent expenses, shipping service, 1926	880. 52
Contingent expenses, shipping service, 1927	8, 479. 61
Enforcement of navigation laws, 1926	4, 676. 46
Enforcement of navigation laws, 1927	80, 969. 83
Enforcement of wireless communication laws, 1925	7. 86

Bureau of Navigation—Continued.	
Enforcement of wireless communication laws, 1926	$11, 764. 46
Enforcement of wireless communication laws, 1927	210, 380. 37
Preventing overcrowding of passenger vessels, 1925	7. 25
Preventing overcrowding of passenger vessels, 1926	1, 257. 63
Preventing overcrowding of passenger vessels, 1927	15, 179. 85
Salaries, Bureau of Navigation, 1926	2, 598. 35
Salaries, Bureau of Navigation, 1927	57, 300. 70
Salaries, shipping service, 1926	2, 903. 83
Salaries, shipping service, 1927	32, 324. 24
Refunding moneys erroneously received	1, 157. 70
Refunding charges erroneously exacted	1, 092. 46
Total	523, 454. 92
Bureau of Fisheries:	
Fisheries of Alaska, 1924–25	181. 50
Fish hatchery, Nashua, N. H., 1926–27	23, 045. 12
Fish hatchery, San Marcos, Tex	801. 71
Fish cultural station, Colorado, 1927	2, 352. 36
Miscellaneous expenses, 1923	2. 40
Miscellaneous expenses, 1924	14. 59
Miscellaneous expenses, 1925	477. 76
Miscellaneous expenses, 1926	85, 457. 81
Miscellaneous expenses, 1926–27	32, 020. 74
Miscellaneous expenses, 1927	506, 719. 16
Miscellaneous expenses, 1927–28	41. 61
Pay, officers and crew of vessels, Alaska fisheries service, 1926	1, 070. 00
Power vessel for Alaska fisheries, 1927	11, 203. 41
Protecting seal and salmon fisheries of Alaska, 1925	17. 65
Protecting seal and salmon fisheries of Alaska, 1926	18, 603. 89
Protecting seal and salmon fisheries of Alaska, 1927	198, 029. 56
Protecting seal and salmon fisheries of Alaska, 1924–25	375. 32
Protecting seal and salmon fisheries of Alaska, 1926–27	91, 682. 77
Salaries, Bureau of Fisheries, 1926	42, 483. 14
Salaries, Bureau of Fisheries, 1927	617, 525. 84
Upper Mississippi River fish refuge	10, 610. 83
Upper Mississippi River fish refuge, 1927	273. 32
Total	1, 642, 990. 49
Bureau of the Census:	
Census of agriculture, 1925–26	2, 113. 45
Census of agriculture, 1925–1927	146, 730. 97
Collecting statistics, 1924	3. 80
Collecting statistics, 1926	92, 128. 78
Collecting statistics, 1927	764, 345. 56
Collecting statistics, 1926–27	78, 886. 18
Salaries, Bureau of the Census, 1926	41, 971. 39
Salaries, Bureau of the Census, 1927	880, 265. 78
Tabulating machines, 1926	2, 649. 52
Tabulating machines, 1927	34, 840. 18
Total	2, 043, 935. 61
Bureau of Lighthouses:	
Aids to navigation, Delaware Bay entrance	3, 540. 63
Aids to navigation, Lighthouse Service	375, 053. 72
Aids to navigation, Chesapeake Bay, Md. and Va	3, 462. 67
Cape Charles Light Vessel, Va	10, 380. 54
Detroit River lights, Mich	9, 294. 76
Diamond Shoal Light Vessel, N. C	4, 440. 00
General expenses, Lighthouse Service, 1919	67. 80
General expenses, Lighthouse Service, 1922	14. 50
General expenses, Lighthouse Service, 1923	72. 31
General expenses, Lighthouse Service, 1924	2. 18
General expenses, Lighthouse Service, 1925	914. 42

Bureau of Lighthouses—Continued.	
General expenses, Lighthouse Service, 1926	$544, 855. 13
General expenses, Lighthouse Service, 1927	3, 688, 490. 63
General expenses, Lighthouse Service, 1927–28	5, 000. 00
Repairs due to hurricane damages, Lighthouse Service	73, 565. 78
Retired pay, Lighthouse Service, 1926	5, 200. 89
Retired pay, Lighthouse Service, 1927	159, 414. 55
Retired pay, Lighthouse Service, 1927–28	27, 460. 21
Radio installation on lighthouse tenders	5, 960. 00
Salaries, Bureau of Lighthouses, 1926	3, 603. 06
Salaries, Bureau of Lighthouses, 1927	80, 003. 16
Salaries, keepers of lighthouses, 1926	60, 283. 65
Salaries, keepers of lighthouses, 1927	1, 873, 117. 45
Salaries, Lighthouse Service, 1926	5, 671. 77
Salaries, Lighthouse Service, 1927	544, 429. 80
Salaries, lighthouse vessels, 1925	72. 50
Salaries, lighthouse vessels, 1926	67, 994. 54
Salaries, lighthouse vessels, 1927	2, 187, 206. 79
Vessels for Lighthouse Service	317, 047. 59
Total	10, 056, 621. 03
Aeronautics Branch:	
Aircraft in commerce, 1927	178, 709. 17
Aircraft in commerce, 1927–28	43, 964. 04
Air-navigation facilities, 1927	223, 066. 60
Air-navigation facilities, 1927–28	44, 405. 69
Total	490, 145. 50
Patent Office:	
Additional employees, 1926	3, 774. 26
Additional employees, 1927	24, 809. 69
Contingent expenses, Patent Office, 1926	2, 658. 02
Disposition of Patent Office models, 1925–26	308. 77
Furniture and filing cases, 1926	5, 144. 50
Furniture and filing cases, 1927	17, 189. 63
Photolithographing, 1925	77. 50
Photolithographing, 1926	23, 277. 81
Photolithographing, 1927	198, 338. 88
Printing and binding, Patent Office, 1926	5. 58
Printing and binding, Patent Office, 1927	407, 214. 47
Public search room, 1927	17, 515. 81
Public use of inventions and defending suits, 1926	312. 64
Public use of inventions and defending suits, 1927	532. 86
Salaries, Patent Office, 1926	97, 075. 06
Salaries, Patent Office, 1927	2, 218, 231. 95
Scientific library, 1925	52. 81
Scientific library, 1926	1, 983. 87
Scientific library, 1927	5, 631. 90
Stationery, Patent Office, 1926	1, 373. 64
Total	3, 025, 509. 65
Coast and Geodetic Survey:	
Air Service, Army (War transfer to Commerce, Coast and Geodetic, act of May 21, 1920), 1927	457. 57
General expenses, Coast and Geodetic Survey, 1925	76. 33
General expenses, Coast and Geodetic Survey, 1926	5, 203. 39
General expenses, Coast and Geodetic Survey, 1927	63, 264. 22
Geological Survey (Interior transfer to Commerce, act of May 21, 1920), 1927	643. 59
Party expenses, Coast and Geodetic Survey, 1924	9. 25
Party expenses, Coast and Geodetic Survey, 1925	12, 825. 67
Party expenses, Coast and Geodetic Survey, 1926	116, 861. 04
Party expenses, Coast and Geodetic Survey, 1927	494, 008. 90
Party expenses, Coast and Geodetic Survey, 1927–28	247. 86

Coast and Geodetic Survey—Continued.	
Geological Survey (Interior transfer to Commerce, act of May 21, 1920), 1926	$624. 47
Pay and allowances, commissioned officers, Coast and Geodetic Survey, 1923	54. 00
Pay and allowances, commissioned officers, Coast and Geodetic Survey, 1924	301. 05
Pay and allowances, commissioned officers, Coast and Geodetic Survey, 1925	132. 00
Pay and allowances, commissioned officers, Coast and Geodetic Survey, 1926	41, 492. 49
Pay and allowances, commissioned officers, Coast and Geodetic Survey, 1927	431, 003. 76
Pay, etc., officers and men, vessels, Coast Survey, 1926	93, 617. 36
Pay, etc., officers and men, vessels, Coast Survey, 1927	490, 880. 33
Repairs of vessels, Coast Survey, 1925	13. 05
Repairs of vessels, Coast Survey, 1926	15, 318. 91
Repairs of vessels, Coast Survey, 1927	66, 704. 64
Salaries, Coast and Geodetic Survey, 1926	21. 23
Salaries, Coast and Geodetic Survey, 1927	423, 809. 30
Total	2, 257, 570. 41
Bureau of Mines:	
Air Service, Army (War transfer to Commerce, Bureau of Mines, act of May 21, 1920), 1925	13, 212. 21
Air Service, Army (War transfer to Commerce, Bureau of Mines, act of June 5, 1924), 1925	49. 57
Aviation, Navy (Navy transfer to Commerce, Bureau of Mines, act of May 21, 1920), 1924	9. 17
Aviation, Navy (Navy transfer to Commerce, Bureau of Mines, act of May 21, 1920), 1925	12, 026. 01
Care, etc., buildings and grounds, Bureau of Mines, Pittsburgh, Pa., 1926	3, 138. 54
Care, etc., buildings and grounds, Bureau of Mines, Pittsburgh, Pa., 1927	60, 621. 12
Contingent expenses, Bureau of Mines, 1926	2, 159. 90
Expenses, mining experiment stations, 1926	13, 381. 51
Expenses, mining experiment stations, 1927	162, 806. 03
General expenses, Bureau of Mines, 1926	4, 971. 93
General expenses, Bureau of Mines, 1927	74, 782. 97
Helium, conservation, production, and exploitation, Bureau of Mines (act of March 24, 1925), 1926	57, 594. 56
Helium, conservation, production, and exploitation, Bureau of Mines (act of April 29, 1926), 1927	242, 341. 98
Helium, production and conservation, Bureau of Mines, 1927–28	118. 18
Helium investigations, 1927	68, 352. 20
Helium reserve, 1926	80, 000. 00
Investigating mine accidents, 1919	15. 00
Investigating mine accidents, 1925	18. 74
Investigating mine accidents, 1926	19, 578. 20
Investigating mine accidents, 1927	381, 284. 38
Investigating potash deposits, 1927	34, 244. 89
Maintenance and operation fuel yards, District of Columbia, Bureau of Mines, 1925–26	2, 721. 85
Maintenance and operation fuel yards, District of Columbia, Bureau of Mines, 1926–27	1, 780, 335. 79
Mineral mining investigations, Bureau of Mines, 1926	8, 683. 77
Mineral mining investigations, Bureau of Mines, 1927	135, 331. 01
Mining investigations in Alaska, 1926	1, 061. 25
Mining investigations in Alaska, 1927	10, 379. 78
Mineral resources, 1926	5, 653. 36
Mineral resources, 1927	112, 623. 58
Oil, gas, and oil shale investigations and leasings, Bureau of Mines, 1925	9. 04
Oil, gas, and oil shale investigations and leasings, Bureau of Mines, 1926	17, 703. 96

Bureau of Mines—Continued.	
Oil, gas, and oil shale investigations, Bureau of Mines, 1927	$202, 782. 36
Oil shale investigations, 1925–26	29, 989. 58
Oil shale investigations, 1927	88, 529. 10
Operating mine rescue cars and stations, 1925	233. 24
Operating mine rescue cars and stations, 1926	25, 968. 92
Operating mine rescue cars and stations, 1927	262, 457. 66
Printing and binding, Bureau of Mines, 1925	5, 038. 81
Printing and binding, Bureau of Mines, 1926	36, 218. 39
Stationery, Bureau of Mines, 1926	2, 380. 03
Testing fuel, Bureau of Mines, 1925	25. 06
Testing fuel, Bureau of Mines, 1926	6, 873. 39
Testing fuel, Bureau of Mines, 1927	143, 528. 66
Total	4, 109, 235. 68
Grand total	32, 279, 019. 88

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

Coast and Geodetic Survey:	
Sale of charts, publications, old property, etc	$67, 230. 92
Miscellaneous refunds	2. 70
* Bureau of the Census: Sale of publications, etc	769. 00
Bureau of Fisheries:	
Sale of fur-seal skins	259, 751. 45
Sale of fox skins	21, 008. 08
Sale of seal oil	1, 302. 43
Meals furnished employees at isolated stations	1, 604. 92
Sale of old property	4, 697. 78
Bureau of Standards:	
Sale of old property	52. 67
Test fees	66, 485. 28
Steamboat Inspection Service: Sale of old property	26. 35
Bureau of Lighthouses:	
Earnings on radiograms	25. 30
Miscellaneous refunds	56, 759. 54
Reimbursement for loss and damage to Government property	2, 948. 52
Rentals	4, 000. 18
Bureau of Foreign and Domestic Commerce:	
Registration fees etc., China trade act	1, 225. 00
Miscellaneous refunds	5, 160. 93
Office of the Secretary:	
Certification fees (37 Stat. 497)	217. 50
Miscellaneous refunds	665. 89
Patent Office: Patent fees, etc	3, 464, 632. 41
Bureau of Mines:	
Analysis samples	7, 579. 75
Miscellaneous refunds	1, 820. 19
Bureau of Navigation:	
Tonnage tax	2, 245, 511. 68
Navigation fees	240, 986. 02
Navigation fines	103, 734. 21
Miscellaneous refunds	2. 25
Total	6, 558, 200. 95

The following unexpended balances of appropriations were turned into the surplus fund June 30, 1927, in accordance with the act of June 20, 1874 (18 Stat. 110–111):

Salaries, Office of Secretary of Commerce, 1922	$13. 54
Salaries, Office of Secretary of Commerce, 1925	11, 149. 93
Increase of compensation, Department of Commerce, 1919	20. 00
Increase of compensation, Department of Commerce, 1922	3. 34
Increase of compensation, Department of Commerce, 1924	84. 67
Contingent expenses, Department of Commerce, 1924	8. 30

Contingent expenses, Department of Commerce, 1925	$9, 933. 18
Rent, Department of Commerce, 1925	200. 04
Salaries, Bureau of the Census, 1925	2, 307. 81
Collecting statistics, Bureau of the Census, 1923	. 35
Collecting statistics, Bureau of the Census, 1924	1. 00
Collecting statistics, Bureau of the Census, 1925	6, 922. 98
Expenses of the Fourteenth Census, 1920–1922	. 50
Tabulating machines, Bureau of the Census, 1925	92. 04
Salaries, Bureau of Foreign and Domestic Commerce, 1925	921. 78
Commercial attachés, Department of Commerce, 1919	57. 21
Commercial attachés, Department of Commerce, 1920	512. 36
Commercial attachés, Departemnt of Commerce, 1921	31. 76
Commercial attachés, Department of Commerce, 1922	630. 63
Commercial attachés, Department of Commerce, 1923	470. 40
Commercial attachés, Department of Commerce, 1924	28. 76
Commercial attachés, Department of Commerce, 1925	23, 638. 57
Compiling foreign trade statistics, Department of Commerce, 1925	8, 728. 75
Directory of foreign buyers, 1925	310. 85
District and cooperative office service, Department of Commerce, 1924	1. 74
District and cooperative office service, Department of Commerce, 1925	7, 959. 30
Enforcement of the China trade act, 1925	3, 274. 82
Export industries, Department of Commerce, 1925	5, 679. 30
Investigating sources of crude rubber, 1923–24	3, 345. 69
Investigating sources of crude rubber, 1925	2, 794. 38
Investigation of foreign trade restrictions, 1925	887. 15
Promoting commerce, Department of Commerce, 1920	152. 00
Promoting commerce, Department of Commerce, 1921	157. 44
Promoting commerce, Department of Commerce, 1922	247. 69
Promoting commerce, Department of Commerce, 1923	540. 48
Promoting commerce, Department of Commerce, 1924	333. 06
Promoting commerce, Department of Commerce, 1925	13, 388. 60
Promoting commerce, South and Central America, 1923	255. 44
Promoting commerce, South and Central America, 1924	336. 89
Promoting commerce, South and Central America, 1925	1, 789. 04
Promoting commerce in the Far East, 1922	895. 62
Promoting commerce in the Far East, 1923	440. 31
Promoting commerce in the Far East, 1924	64. 92
Promoting commerce in the Far East, 1925	8, 266. 44
Raw material investigations, 1925	7, 296. 06
Transportation of families and effects of officers and employees, Bureau of Foreign and Domestic Commerce, 1924	330. 12
Transportation of families and effects of officers and employees, Bureau of Foreign and Domestic Commerce, 1925	63. 11
Transportation and interment of remains of officers and employees, Bureau of Foreign and Domestic Commerce, 1925	1, 453. 93
Care, etc., of buildings and grounds, Bureau of Mines, Pittsburgh, Pa., 1925	504. 40
Enforcement of mineral leases, Bureau of Mines, 1925	4, 932. 40
Expenses, mining experiment stations, Bureau of Mines, 1925	1, 116. 52
General expenses, Bureau of Mines, 1925	2, 341. 89
Investigating mine accidents, 1925	3, 009. 38
Mineral mining investigations, Bureau of Mines, 1925	2, 505. 43
Mining investigations in Alaska, 1925	759. 66
Oil, gas, and oil shale investigations and leasing, Bureau of Mines, 1924	43. 46
Oil, gas, and oil shale investigations and leasing, Bureau of Mines, 1925	68, 289. 87
Operating mine rescue cars and stations, Bureau of Mines, 1925	1, 968. 64
Purchase and equipment of mine rescue cars, Bureau of Mines, 1925	67. 14
Testing fuel, Bureau of Mines, 1925	1, 516. 59
Salaries, Office of Supervising Inspector General, Steamboat Inspection Service, 1925	170. 93
Salaries, Steamboat Inspection Service, 1925	14, 176. 01
Clerk hire, Steamboat Inspection Service, 1925	3, 181. 57
Contingent expenses, Steamboat Inspection Service, 1921	76. 85

Contingent expenses, Steamboat Inspection Service, 1922	$4. 92
Contingent expenses, Steamboat Inspection Service, 1924	715. 98
Contingent expenses, Steamboat Inspection Service, 1925	13, 803. 20
Salaries, Bureau of Navigation, 1925	14. 45
Salaries, shipping service, 1925	1, 530. 78
Clerk hire, shipping service, 1925	1, 513. 80
Contingent expenses, shipping service, 1925	521. 01
Instruments for counting passengers, 1925	2. 00
Admeasurement of vessels, 1925	13. 47
Preventing overcrowding of passenger vessels, 1925	1, 896. 04
Enforcement of navigation laws, 1925	26. 32
Enforcement of wireless communication laws, 1924	7. 34
Enforcement of wireless communication laws, 1925	167. 94
Salaries, Patent Office, 1923	32. 50
Salaries, Patent Office, 1924	33. 11
Salaries, Patent Office, 1925	30, 322. 93
Additional employees, Patent Office, 1924–25	718. 40
Contingent expenses, Patent Office, 1925	101. 62
Furniture and filing cases, Patent Office, 1925	659. 32
Photolithographing, Patent Office, 1925	3, 692. 44
Printing and binding, Patent Office, 1925	3, 383. 81
Public use of inventions and defending suits, Patent Office, 1925	409. 88
Scientific library, Patent Office, 1925	488. 88
Stationery, Patent Office, 1925	147. 17
Salaries, Bureau of Standards, 1925	3, 013. 20
Equipment, Bureau of Standards, 1925	394. 40
General expenses, Bureau of Standards, 1921	2. 16
General expenses, Bureau of Standards, 1923	12. 57
General expenses, Bureau of Standards, 1924	5. 76
General expenses, Bureau of Standards, 1925	5, 835. 06
Improvement and care of grounds, Bureau of Standards, 1925	163. 00
Color standardization, Bureau of Standards, 1925	200. 86
Gauge standardization, Bureau of Standards, 1925	853. 23
High-temperature investigations, Bureau of Standards, 1925	12. 36
Industrial research, Bureau of Standards, 1923	6. 18
Industrial research, Bureau of Standards, 1925	1, 948. 01
Investigation of automotive engines, Bureau of Standards, 1925	488. 79
Investigation of clay products, Bureau of Standards, 1925	215. 43
Investigation of fire-resisting properties, Bureau of Standards, 1925	203. 37
Investigation of mine scales and cars, Bureau of Standards, 1923	3. 24
Investigation of mine scales and cars, Bureau of Standards, 1925	366. 46
Investigation of optical glass, Bureau of Standards, 1925	76. 48
Investigation of public utility standards, Bureau of Standards, 1924	2. 00
Investigation of public utility standards, Bureau of Standards, 1925	1, 443. 06
Investigation of radioactive substances, Bureau of Standards, 1925	67. 88
Investigation of textiles, etc., Bureau of Standards, 1925	162. 18
Metallurgical research, Bureau of Standards, 1925	166. 27
Radio research, Bureau of Standards, 1925	79. 66
Rope investigations, Bureau of Standards, 1925	116. 32
Sound investigation, Bureau of Standards, 1925	52. 53
Standardization of equipment, Bureau of Standards, 1923	9. 01
Standardization of equipment, Bureau of Standards, 1924	. 30
Standardization of equipment, Bureau of Standards, 1925	282. 64
Standardizing mechanical appliances, Bureau of Standards, 1925	64. 40
Standard materials, Bureau of Standards, 1925	25. 87
Sugar standardization, Bureau of Standards, 1925	274. 48
Testing machines, Bureau of Standards, 1925	100. 18
Testing miscellaneous materials, Bureau of Standards, 1925	1, 006. 18
Testing railroad scales, etc., Bureau of Standards, 1922	3. 20
Testing railroad scales, etc., Bureau of Standards, 1923	. 06
Testing railroad scales, etc., Bureau of Standards, 1924	36. 37
Testing railroad scales, etc., Bureau of Standards, 1925	235. 83
Testing structural materials, Bureau of Standards, 1924	19. 00
Testing structural materials, Bureau of Standards, 1925	4, 956. 54
Pay and allowances, commissioned officers, Coast and Geodetic Survey, 1921	404. 95

Pay and allowances, commissioned officers, Coast and Geodetic Survey, 1922	$1, 030. 51
Pay and allowances, commissioned officers, Coast and Geodetic Survey, 1925	41, 932. 50
Salaries, Coast and Geodetic Survey, 1925	15, 541. 17
Party expenses, Coast and Geodetic Survey, 1923	2. 76
Party expenses, Coast and Geodetic Survey, 1924	14. 27
Party expenses, Coast and Geodetic Survey, 1925	22, 108. 87
General expenses, Coast and Geodetic Survey, 1925	1, 137. 44
Pay, etc., of officers and men, vessels, Coast Survey, 1925	50, 882. 25
Repairs of vessels, Coast Survey, 1925	994. 39
Salaries, Bureau of Lighthouses, 1925	3, 622. 09
Retired pay, Lighthouse Service, 1925	2, 083. 66
General expenses, Lighthouse Service, 1917	15. 51
General expenses, Lighthouse Service, 1924	39. 47
General expenses, Lighthouse Service, 1925	28, 945. 68
Salaries, keepers of lighthouses, 1925	4, 723. 89
Salaries, lighthouse vessels, 1925	14, 672. 13
Salaries, Lighthouse Service, 1925	4, 184. 24
Cape Charles Light Vessel, Va	117. 45
Aids to navigation, Florida coast	28. 22
Sand Island Light Station, Ala	250. 97
Aids to navigation, Alaska	9. 29
Salaries, Bureau of Fisheries, 1925	35, 804. 13
Miscellaneous expenses, Bureau of Fisheries, 1919	11. 92
Miscellaneous expenses, Bureau of Fisheries, 1922	27. 35
Miscellaneous expenses, Bureau of Fisheries, 1923	31. 92
Miscellaneous expenses, Bureau of Fisheries, 1924	19. 15
Miscellaneous expenses, Bureau of Fisheries, 1924–25	4, 022. 59
Miscellaneous expenses, Bureau of Fisheries, 1925	875. 62
Pay, officers and crew of vessels, Alaska fisheries service, 1925	5, 073. 16
Protecting seal and salmon fisheries of Alaska, 1924–25	711. 13
Protecting seal and salmon fisheries of Alaska, 1925	219. 25
Fisheries of Alaska, 1924–25	3, 392. 14
Fish rescue station, Mississippi River, 1925	114. 13
Total	556, 839. 05

In the last nine years the Department of Commerce has turned back unused into the Treasury the following amounts:

June 30, 1919	$476, 045. 10	June 30, 1925	$1, 005, 909. 02
June 30, 1920	1, 149, 363. 28	June 30, 1926	811, 017. 12
June 30, 1921	4, 042, 434. 38	June 30, 1927	556, 839. 05
June 30, 1922	546, 440. 71		
June 30, 1923	730, 397. 27	Total	10, 391, 281. 51
June 30, 1924	1, 072, 835. 58		

APPOINTMENT DIVISION

The addition of the Aeronautics Branch accounts for most of the increase in the number of permanent employees of the department. The radio activities of the department were segregated from the Bureau of Navigation and organized as a separate unit, which accounts for the decrease in the personnel of that bureau. The following table shows, by bureau, nature of appointment and sex, the strength of the personnel of the department at the end of the fiscal year 1927:

Bureau	Permanent		Temporary		Total permanent and temporary		Grand total
	In District of Columbia	In field	In District of Columbia	In field	Male	Female	
Office of the Secretary	133				80	53	133
Office of the Assistant Secretary for Aeronautics	40	22			37	25	62
Bureau of the Census	737	794	168	761	1,786	674	2,460
Bureau of Foreign and Domestic Commerce	644	698	7	2	794	557	1,351
Bureau of Standards	784	48	11	7	746	104	850
Bureau of Fisheries	73	373		225	624	47	671
Bureau of Lighthouses	71	5,497	3	232	5,517	286	5,803
Coast and Geodetic Survey	206	643		96	911	34	945
Bureau of Navigation	30	108	2	19	134	25	159
Radio Division	19	60	2		50	31	81
Steamboat Inspection Service	15	344			306	53	359
Patent Office	1,139		2		824	317	1,141
Bureau of Mines	248	548	9	144	759	190	949
Total	4,139	9,135	204	1,486	12,568	2,396	14,964

The following table shows the changes in the department's personnel during the last fiscal year:

Bureau	Appointments [1]									
	Permanent						Temporary		Grand total	
	Competitive		Excepted and noncompetitive		Unclassified					
	District of Columbia	Field	District of Columbia	Field	District of Columbia	Field	District of Columbia	Field	District of Columbia	Field
Office of the Secretary	93	3	9	23	1	1	2	2	105	29
Radio Division	7	2					2		9	2
Bureau of the Census	41	94					250	1,639	291	1,733
Bureau of Foreign and Domestic Commerce	158	70	31	58	2		11	32	202	160
Bureau of Standards	209	12	3	18	21	3	46	3	279	36
Bureau of Fisheries	7	63		18		7	5	38	12	126
Bureau of Lighthouses	17	287	2	31			2	132	21	450
Coast and Geodetic Survey	19	41		10			5	1	24	52
Bureau of Navigation	7	13		55			5	9	12	77
Steamboat Inspection Service	3	29						3	3	32
Patent Office	150						35		185	
Bureau of Mines	35	79	2	44	4	34	28	57	69	214
Total	746	693	47	257	28	45	391	1,916	1,212	2,911
Grand total	1,439		304		73		2,307		4,123	

[1] Includes appointments of the following character: Presidential; by selection from civil-service certificate; under Executive order; to excepted positions; by reason of transfer within the department, or from other departments or independent establishments; and by reinstatement.

Bureau	Separations [2]									
	From permanent positions						From temporary positions		Total	
	Competitive		Excepted and noncompetitive		Unclassified					
	District of Columbia	Field	District of Columbia	Field	District of Columbia	Field	District of Columbia	Field	District of Columbia	Field
Office of the Secretary	47	3	1	6					48	9
Radio Division	2	2					3	1	5	3
Bureau of the Census	84	72					324	1,770	408	1,842
Bureau of Foreign and Domestic Commerce	130	80		5			20	15	150	100
Bureau of Standards	139	7			1		66	5	206	12
Bureau of Fisheries	4	45		1			1	30	5	76
Bureau of Lighthouses	5	306		1			1	88	6	395
Coast and Geodetic Survey	17	30		6			13	2	30	38
Bureau of Navigation	8	15		31			4	14	12	60
Steamboat Inspection Service	3	18					2	3	5	21
Patent Office	197						22		219	
Bureau of Mines	36	81	1	40		1	20	73	57	195
Total	672	659	2	90	1	1	476	2,001	1,151	2,751
Grand total	1,331		92		2		2,477		3,902	

[2] Includes separations by reason of resignation, discontinuance, retirement, removal, death, transfer within the department, and transfer from the department to other departments or independent establishments.

Bureau	Other changes						All changes		
	Promotions		Reductions		Miscellaneous changes [3]				
	District of Columbia	Field	District of Columbia	Field	District of Columbia	Field	District of Columbia	Field	Grand total
Office of the Secretary	108	4	1		16	8	278	50	328
Radio Division	4	4			2	2	20	11	31
Bureau of the Census	231		1		617	2	1,548	3,577	5,125
Bureau of Foreign and Domestic Commerce	552	318	3	4	62	61	969	643	1,612
Bureau of Standards	463	9	4	1	72	10	1,024	68	1,092
Bureau of Fisheries	58	82		2	4	64	79	350	429
Bureau of Lighthouses	43	961		99	10	188	80	2,093	2,173
Coast and Geodetic Survey	188	44	1	1	4	27	247	162	409
Bureau of Navigation	22	100			7	45	53	282	335
Steamboat Inspection Service	7	106		5	1	11	16	175	191
Patent Office	764		31		64		1,263		1,263
Bureau of Mines	146	233	1	1	30	164	303	807	1,110
Total	2,586	1,861	42	113	889	582	5,880	8,218	14,098

[3] Includes reappointments by reason of change of station, name, designation, extensions of temporary appointments, and temporary promotions and reductions.

The leave statistics of the department for the calendar year 1926 reveal about the same story as those of the previous year. Attention might be called to the fact that the average amount of sick leave taken by the employees of the department was only 6.36 days and 27 per cent of the employees took no sick leave whatever. The following statement shows, by bureau, the total and average amounts of annual

and sick leave taken by the employees of the department in the District of Columbia, arranged according to sex, during the year 1926:

[NOTE.—In the count of leave all periods of one-half day or over were counted as a whole day; periods of less than one-half day were omitted.]

Bureau	Number	Annual leave		Sick leave		Total leave		Average, 1925
		Days	Average	Days	Average	Days	Average	
MALE								
Office of the Secretary	62	1,675	27.02	214	3.45	1,889	30.47	30.04
Bureau of the Census	283	8,187	28.93	1,085	3.83	9,272	32.76	34.67
Bureau of Foreign and Domestic Commerce	252	6,396	25.38	1,430	5.67	7,826	31.06	31.39
Bureau of Standards	588	14,806	25.18	2,197	3.73	17,003	28.92	31.92
Bureau of Fisheries	43	1,050	24.42	205	4.77	1,255	29.19	30.32
Bureau of Lighthouses	24	618	25.75	131	5.46	749	31.21	37.09
Coast and Geodetic Survey	160	4,628	28.93	1,016	6.35	5,644	35.28	32.09
Bureau of Navigation	20	561	28.05	122	6.10	683	34.15	28.21
Steamboat Inspection Service	6	87	14.50	30	5.00	117	19.50	25.17
Patent Office	665	18,921	28.45	3,747	5.63	22,668	34.08	--------
Bureau of Mines	106	2,643	23.93	496	4.68	3,139	29.61	--------
Total and average	2,209	59,572	26.97	10,673	4.83	70,245	31.80	32.25
FEMALE								
Office of the Secretary	43	1,225	28.49	339	7.88	1,564	36.37	33.47
Bureau of the Census	453	13,446	29.68	3,812	8.42	17,258	38.10	38.72
Bureau of Foreign and Domestic Commerce	229	6,638	28.99	2,446	10.68	9,084	39.67	39.39
Bureau of Standards	79	2,271	28.75	748	9.47	3,019	38.22	36.36
Bureau of Fisheries	24	705	29.38	233	9.71	938	39.08	38.91
Bureau of Lighthouses	10	295	29.50	117	11.70	412	41.20	38.67
Coast and Geodetic Survey	16	474	29.63	110	6.87	584	36.50	38.91
Bureau of Navigation	28	802	28.64	319	11.39	1,121	40.03	36.13
Steamboat Inspection Service	7	183	26.15	62	8.86	245	35.00	35.14
Patent Office	289	8,329	28.82	2,412	8.35	10,741	37.17	--------
Bureau of Mines	82	2,371	28.91	806	9.83	3,177	38.74	--------
Total and average	1,260	36,739	29.16	11,404	9.05	48,143	38.21	38.37
TOTAL								
Office of the Secretary	105	2,900	27.62	553	5.27	3,453	32.89	31.43
Bureau of the Census	736	21,633	29.39	4,897	6.65	26,530	36.04	37.13
Bureau of Foreign and Domestic Commerce	481	13,034	27.10	3,876	8.06	16,910	35.16	35.02
Bureau of Standards	667	17,077	25.60	2,945	4.42	20,022	30.02	32.45
Bureau of Fisheries	67	1,755	26.19	438	6.54	2,193	32.73	33.06
Bureau of Lighthouses	34	913	26.85	248	7.29	1,161	34.14	37.53
Coast and Geodetic Survey	176	5,102	28.99	1,126	6.40	6,228	35.39	32.91
Bureau of Navigation	48	1,363	28.40	441	9.18	1,804	37.58	32.55
Steamboat Inspection Service	13	270	20.76	92	7.08	362	27.85	30.54
Patent Office	954	27,250	28.56	6,159	6.46	33,409	35.02	--------
Bureau of Mines	188	5,014	26.67	1,302	6.93	6,316	33.60	--------
Total and average	3,469	96,311	27.76	22,077	6.36	118,388	34.12	34.53

The average salary of all appointed personnel in the District of Columbia increased from $1,906 on January 1, 1926, to $2,035 on January 1, 1927. The practice of making efficiency ratings only once a year, namely, on May 15, has, as a whole, worked quite satisfactorily and considerably reduced the amount of clerical work involved and minimized the feeling of unrest caused by the more frequent ratings. The average efficiency rating for all employees in the department as of May 15, 1927, was 82.72. During the year approximately 1,800 classification sheets were forwarded to the Personnel Classification Board for allocation. There were 137 appeals from classification allocation received in the department, of which 130 have been forwarded to the Personnel Classification

Board. The work in connection with the furnishing of abstracts of official record, the handling of applications for refund of contributions made to the retirement fund, and the furnishing of leave records in connection with retirement cases continues to be quite a factor in the division's work.

During the fiscal year 1927, 72 employees were retired on annuity. Under the general civil service retirement act, 40 were retired on an average annuity of $797. Under the Lighthouse Service retirement system, 21 were retired on account of age, with an average annuity of $950, and 11 by reason of disability, with an average annuity of $882. The total number of retirements under the two systems to date is 590.

DIVISION OF PUBLICATIONS

Work of the division.—The division of publications is responsible for the economical expenditure of the printing and binding appropriation of the department. This responsibility involves the conduct of all business the department transacts with the Government Printing Office, general supervision over all printing (including editing and preparing copy, illustrating, etc., and binding for the department, keeping records of incurred liabilities and expenditures, and approving for payment the vouchers therefor. Through this centralization of supervision the department exercises rigid economy in its expenditures for printing and binding. The editorial force of the division (1) reads critically manuscripts submitted for publication and makes such emendations or suggestions as seem necessary to secure compliance with the law and the department's standards; (2) supplies or revises titles, lists of contents and illustrations, indexes, abstracts, illustration legends and headlines, etc.; and (3) determines, in accordance with the law and the policies adopted thereunder by the Public Printer, the form and style of the department's publications.

Appropriations and expenditures.—The following statement shows for the fiscal years 1926 to 1928, inclusive, the amounts available for printing and binding and the unexpended balances of the appropriations for 1926 and 1927:

	Fiscal year		
	1926	1927	1928
Services other than the Patent Office:			
Amount available	[1] $594,870.00	[2] $660,920.00	[3] $700,000.00
Expenditures	594,613.24	[4] 657,071.66	
Balance	256.76	3,848.34	
Patent Office:			
Amount available	1,255,000.00	1,032,311.00	1,135,000.00
Expenditures	1,252,949.06	[4] 1,031,311.89	
Balance	2,050.94	999.11	

[1] Includes $64,870 for the Bureau of Mines, which amount was transferred to the department from appropriation made to the Interior Department.
[2] Includes $5,000 made available for printing and binding for the Aeronautics Branch by the second deficiency act, 1926 (Public 492, 69th Cong.).
[3] Includes $25,000, available for printing and binding for the Aeronautics Branch, contained in Public Act 638, 69th Congress.
[4] Estimated (Oct. 1, 1927); exact figures for 1927 can not be given until all work ordered in that year is completed and billed. Expenditures will approximate the amounts available.

Sales of publications.—Total receipts from sales of the department's publications for the fiscal year 1926 (the latest period for which complete data are available) were $535,061.73, compared with $473,591.98 for 1925. The following table presents the details in comparison for the two years by selling agencies and issuing offices:

Sales	Receipts	
	1925	1926
By the Superintendent of Documents:		
Miscellaneous sales	$82,476.40	$88,303.84
Subscriptions	62,267.01	64,190.01
Total	144,743.41	152,993.85
By Coast and Geodetic Survey: Coast pilots, inside route pilots, tide tables, current tables, and charts	49,850.02	64,203.58
By Patent Office: Specifications of patents, reissues, etc., trade-mark section and decision leaflet of Official Gazette, and classification bulletins and definitions	278,998.55	317,864.30
Grand total	473,591.98	535,061.73

DIVISION OF SUPPLIES

Purchases.—In compliance with the regulations governing surplus property this office directed the ordering offices of our field services to avail themselves of surplus property or cleared their proposals for open-market purchases. This action related to the surplus of the department, the records being centralized in this office, and also of other Government branches which reported to the General Supply Committee.

There was obtained, without transfer of funds, through the cooperation of the Chief Coordinator's office of the Bureau of the Budget, office equipment, clothing, etc., valued at approximately $66,000, which had been declared surplus by other departments.

The amount of $1,389,574.48 was expended by this office on the 15,200 orders issued and the freight, travel, and miscellaneous accounts. This is a very marked increase in the quantity of orders placed and also in the amount of expenditures. These increases were caused principally by the Aeronautics Branch of the department, which has made many large contracts for lighting of airways and landing fields.

Real estate.—From the incomplete information now on hand, it is estimated there will be a decrease in the rentals of the department of approximately $700 from the rentals paid during the fiscal year 1927. This decrease is due to lower rentals in several cities and also to the fact that the Dallas, Tex., office of the Bureau of Mines has been moved into the Federal Building of that city.

TRAFFIC OFFICE

The operation of the traffic office, in cooperation with the various bureaus, has continued to effect substantial savings in both freight and passenger transportation costs. Wherever possible advantage was taken of opportunity to consolidate shipments of freight, the use of its own vessels and Government transports, routing by rail and water, and using land-grant routes. Savings on passenger travel were made by use of round trip, reduced rates, and through reservations.

DEPARTMENT LIBRARY

The growth of the department library has been continuous and the increased use denotes its value. It consists of a well-selected collection of books, pamphlets, and other material directly bearing upon the work of the department, which is catalogued, filed, and made readily available, and is invaluable in the work of the bureaus depending upon it for service. A great handicap at present is the crowded condition of the shelves, as the space is wholly inadequate and the working quarters for the staff also insufficient for the number of people necessary to man the library. During the fiscal year 1927, 6,204 books and pamphlets were added to the collection, making a total of 129,306 books and pamphlets now on file. The circulation in the department building was 18,216 books, which indicates the activities of the library in this regard. This number does not include periodicals or the books used in the library. Books catalogued amounted to 3,140 and the continuations to 3,064, making a total of 6,204. Discards numbered 5,561 thus providing space for new material. Books classified amounted to 2,136. Other books added to the collection had Library of Congress cards which gave the class numbers. Books and periodicals collated for binding were 4,931 and books sent to the bindery were 750. Cards for new books or continuations filed in the catalogue trays amounted to 14,347, thus enriching the research possibilities of the library. Books borrowed from the Library of Congress and other libraries numbered 3,642.

Too much stress can not be laid upon the periodical collection, as it contains the most up-to-date information on business conditions and other matters of interest. At the end of the fiscal year, 1,781 titles of periodicals were currently received; these were recorded and routed to the various divisions and officials, the routings numbering 2,158.

There are no figures to show the amount of reference work done, but it is a strong feature of the service. The demands are ever increasing and many important investigations are assisted by this branch of the library service.

The number of people from other Government departments and independent establishments using the library was 690.

During the year several lists were compiled; the most comprehensive being "A list of periodicals published in the United States relating to engineering."

SOLICITOR'S OFFICE

During the fiscal year ended June 30, 1927, 231 contracts, totaling $2,015,455.42, together with 69 contracts of indeterminate amounts; 226 leases amounting to $166,933.83; 29 revocable licenses amounting to $2,014; 2 insurance policies, amounting to $150,991; 22 deeds, involving the sum of $95,180; 89 contract bonds amounting to $613,630.10; and 65 official bonds amounting to $509,000 were examined (approved, disapproved, drafted, redrafted, or modified).

The number of legal opinions rendered, formal and informal (memorandum) totaled 194 (a great many verbal opinions of which no record is kept were also rendered during the year); legislative matters

handled which concern the Department of Commerce (drafting and redrafting of bills, reports relative thereto, etc.) numbered 28. Power of attorney cards, authorizing agents to execute official and contract bonds for surety companies, totaled 3,624. In addition 10,503 miscellaneous matters, embracing everything submitted for the advice or suggestion of the solicitor, or for the formulation of departmental action, not included in the foregoing items, were handled by this office.

Very truly yours,

E. W. LIBBEY,
Chief Clerk and Superintendent.

OFFICE OF THE DIRECTOR OF AERONAUTICS

DEPARTMENT OF COMMERCE,
OFFICE OF THE DIRECTOR OF AERONAUTICS,
Washington, July 1, 1927.

Hon. HERBERT HOOVER,
Secretary of Commerce.

DEAR MR. SECRETARY: In response to your request the following report is submitted, describing the state of air traffic and the aeronautic industry and briefly summarizing the activities of the aeronautics branch of the department during the fiscal year ended June 30, 1927:

I. ORGANIZATION OF THE AERONAUTICS BRANCH IN THE DEPARTMENT OF COMMERCE

The air commerce act, approved May 20, 1926, provided comprehensively for the promotion and regulation of civil aeronautics. Among other things it provided for the establishment and maintenance of civil airways, and their equipment with intermediate landing fields, beacon lights, signal and radio apparatus, and other aids to air navigation; the establishment of air traffic rules; the inspection and licensing of aircraft, the examination and licensing of airmen, and the identification of aircraft; the collection and dissemination of information pertaining to air commerce and the state of the art, including data concerning the causes of accidents; the establishment of a suitable weather service on airways; the charting of airways, and the publication of air maps; the promotion of air commerce, industry, and trade; and the conduct of scientific research and development work tending to the improvement of facilities for air navigation. The act provided for the rating of air ports as to suitability, and for the encouragement of the establishment and maintenance of air ports by municipalities.

The act did not create a new bureau in the Department of Commerce to perform these functions. The intention was that, so far as practicable, the duties imposed by the act should be distributed among existing agencies of the department.

Accordingly, the task of establishing, maintaining, and operating aids to navigation along air routes was assigned to the Lighthouse Service; the mapping of air routes to the Coast and Geodetic Survey; and the scientific research for the improvement of air-navigation aids to the Bureau of Standards.

The department had no facilities for the examination and licensing of aircraft and airmen, for the enforcement of air-traffic rules, or for the collection and dissemination of aeronautical information. It was necessary to set up new instrumentalities to deal with these matters, and two special divisions were accordingly established—the division of air regulations and the division of air information. For convenience of reference, these two divisions, together with the airways division of the Bureau of Lighthouses, the airway-mapping

section of the Coast and Geodetic Survey, and the aeronautical research division of the Bureau of Standards, are collectively referred to as the aeronautics branch of the department.

During the fiscal year 1927 the work of the respective divisions of the aeronautics branch was directly supervised by the Assistant Secretary for Aeronautics, provided for by the air commerce act. On July 1, 1927, the Secretary of Commerce appointed a Director of Aeronautics, who, under the general direction of the Assistant Secretary for Aeronautics, now has immediate charge of the department's work under the air commerce act.

The appropriations of the aeronautics branch for the fiscal year 1927 aggregated $550,000, in addition to which certain amounts appropriated for the fiscal year 1928 were available for expenditure in the latter part of 1927.

The work of the several divisions constituting the aeronautics branch during the fiscal year, 1927, is summarized below.

AIR REGULATIONS DIVISION

The organization of this division presented one of the most difficult of the year's problems. Its work includes the inspection of aircraft for airworthiness and their registration as aircraft of the United States; the examination and licensing of airmen serving in connection with licensed aircraft; the identification by letter and number of all aircraft, including those not licensed; the investigation of accidents; the enforcement of air-traffic rules; and the rating of air-navigation facilities.

Necessarily the first step was the preparation of the regulations provided for in the air commerce act. There was no precedent for such regulations. Aircraft operations and activities in the United States are on a broader scale and more diversified than in other nations; and the regulations had to take into account existing types of war surplus and rebuilt aircraft as well as anticipate new construction of known types and the development of new types. These things made the drafting of regulations a most difficult and complicated problem. At the same time it was necessary to establish and define classes of licenses for airmen, both pilots and mechanics, and to prepare for their suitable qualification by means of tests and examinations, including tests of physical fitness.

The regulations, as finally adopted and made effective on December 31, 1926, were the result of numerous conferences attended by representatives from every interested branch of aeronautics. They provided in detail for the inspection, registration, and licensing of aircraft, the examination and licensing of pilots and mechanics, and the identification of all aircraft not licensed; and they set up the air traffic rules.

The personnel of the air regulations division must obviously possess unusual qualifications. Excepting clerical and office workers, they must be especially expert in the various phases of aeronautics. Aeronautical engineers and inspectors are required capable of advising with manufacturers and technicians and determining the airworthiness and suitability of new aircraft, both prior to and during construction, including the examination and checking of technical data, drawings, and diagrams. The inspection of aircraft and the exami-

nation and licensing of pilots and mechanicians require a force of inspectors skilled in the maintenance and operation of aircraft, with piloting ability well above the average, and with good personality.

The act provided for a determination of the physical fitness of licensed pilots, and of applicants for license—a service that can be performed only by physicians with knowledge of flight requirements. In considering the work of the air regulations division, it should be remembered that a continuing inspection service for licensed aircraft must be maintained, and that the physical fitness of licensed pilots must be checked at suitable intervals.

During the fiscal year 1927 a good beginning was made in the establishment of the staff of the division and the procurement of necessary equipment. A medical director was appointed to organize the work of giving physical examinations to pilots and to applicants for pilot's licenses, and about 200 physicians and surgeons at various points throughout the country were designated as medical examiners for the aeronautics branch. Fifteen experienced men were given appointment as aircraft and engine inspectors, forming the nucleus of an inspection force which within a year is expected to reach 50. The duties of these men include also the examination of applicants for pilots' and mechanics' license.

In order to facilitate the inspection and examining work it was planned to equip the air regulations division with a limited number of airplanes, and 10 had been purchased or contracted for by the end of the fiscal year, of which 5 had been placed in operation. The department made an effort to adapt to its uses several surplus planes from the War and Post Office Departments, but these planes were not suitable for the department's requirements.

By the close of the fiscal year the air regulations division was fairly well organized, and work of examining applicants for licenses, and inspecting, numbering, and certificating aircraft, was proceeding.

It is estimated that less than half of the total number of airmen in the country have applied for license, and applications have been submitted for the registration or identification of only a small proportion of aircraft in operation. The requirements of the department are not yet fully understood, and many operators will probably delay the submission of applications until the department's representatives get in personal touch with them in the field. Until the staff of inspectors has been substantially enlarged this condition will continue to a greater or less extent. It is estimated that additional civil planes are now being placed in operation at the rate of over 100 a month, and this will increase the air regulations division's problem of bringing all civil craft and their operating personnel under the system of registration and inspection.

The duty of enforcing the air traffic rules as well as the investigation and assessment of penalties for violations devolves upon the air regulations division. These rules are analogous to rules of the road for ground traffic and cover minimum heights at which aircraft may be flown, acrobatic flying over congested areas, crossing aircraft, right of way, dropping objects from aircraft in flight, weather and distress signals, and the display of lights during night flights.

Because of the pressure of the work of examining and licensing aircraft and their personnel, the air regulations division was unable to fulfill its obligations in the examination and rating of airports

and landing facilities. It is apparent that a larger personnel with adequate air transportation will be required if the department is to meet fully its responsibilities under the air commerce act. The number of airports and landing fields has grown beyond any reasonable anticipation, and it is essential that this phase of the inspection work be given attention during the coming year.

AIRWAYS DIVISION (BUREAU OF LIGHTHOUSES)

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

For convenience of administration the airways division is organized in four sections: Administration, extension and construction, maintenance, and weather and communications.

The section of extension and construction is further subdivided into three parts: Survey, for the laying out of airways over the best flying country and the location of intermediate landing fields; lighting, for the installation of lighted aids; and radio construction, for the installation of radiobeacons and radiotelegraph and telephone stations. At the close of the year the personnel of the engineering and construction section included 16 licensed air pilots and 12 engineers.

The maintenance section, responsible for the maintenance and operation of navigation facilities of all types along air routes, carries on its work through the regular district organizations of the Lighthouse Service, augmented by the necessary special personnel. Work in connection with air-navigation facilities has been assigned to lighthouse districts as follows: Third lighthouse district, Staten Island, N. Y., airways from Boston to New York and from New York to Bellefonte; tenth lighthouse district, Buffalo, N. Y., airways from Bellefonte to Bryan; twelfth lighthouse district, Milwaukee, Wis., airways from Bryan to Omaha, from St. Louis to Chicago, and from Dallas to Chicago; eighteenth lighthouse district, San Francisco, Calif., airways from San Francisco to Reno, Los Angeles to Salt Lake City, and Los Angeles to San Francisco and Redding. An additional office was established at Salt Lake City for the maintenance of airways from Omaha to Reno, Salt Lake City to Pasco, and Pueblo to Cheyenne.

The weather and communications section is responsible for the coordination of Weather Bureau forecasts in connection with the special requirements for meteorological service on civil airways and for the maintenance of a communication system designed to secure safety of flight.

On June 30, 1927, 134 persons were on the roll of this division.

NAVIGATION FACILITIES ON CIVIL AIRWAYS

The 1927 appropriation of $300,000 for air-navigation facilities was expended for the establishment of lighting facilities on 1,386 miles of airways. Five routes were included in this mileage, all operated by air-transport companies carrying mail on regular schedules that made it necessary to fly into total darkness at the extremities of the routes. The routes were New York to Boston, St. Louis to Chicago, Dallas to Chicago, Salt Lake City to Pasco, and Los Angeles

to Salt Lake City. Thirty-two lighted intermediate fields were placed on the five routes, and 107 airway lights were established.

Of the 1928 appropriation for air-navigation facilities, $450,000 was available for expenditure on February 24, 1927. From this sum preparations were made to light 1,294 additional miles of airways, and contracts were actually awarded during the fiscal year 1927 for lights on 694 miles.

These contracts provided for lighting one additional route, Pueblo to Cheyenne, and for completing the lighting on the Dallas-Chicago route. Surveys of the routes from Atlanta to New York, from Chicago to Twin Cities, from Detroit to Grand Rapids, and from Los Angeles to San Francisco were under way during the latter part of the year, preparatory to the establishment of intermediate fields and airway lights.

Under the provisions of the air commerce act, the transcontinental airway was transferred to the Department of Commerce at the close of June 30, 1927. The airway extends from New York to San Francisco, 2,612 miles. The facilities on the lighted section from Salt Lake City to New York, 2,041 miles, consist of 92 intermediate fields with beacons and boundary lights, 612 electric and acetylene gas beacons, and 17 radio stations. One hundred and forty-six employees were transferred with the airway. Including the transcontinental, there were, at the close of the fiscal year, 4,121 miles of lighted airways under the jurisdiction of the Department of Commerce, the facilities totaling 124 intermediate fields with beacon and boundary lights, 719 airway beacons, and 17 radio stations.

RADIOBEACONS AND TELEPHONES

A radio equisignal range beacon for aircraft was established at Hadley Field, New Brunswick, N. J., where experimental work has been conducted looking to the development of small airplane receivers suitable for single-pilot planes. Another radiobeacon was installed on the transcontinental airway at Bellefonte by the Bureau of Standards, and experimental work is being carried on at this station also. A third installation is contemplated at Cleveland, where it is expected to carry on radio development work under operating conditions.

Safety of navigation requires that information regarding landing and weather conditions be made available to air pilots approaching terminal fields, as well as periodic information as to changes in barometric pressures at points of known elevation for adjustment of the altimeter while in flight. Installations of radiotelephones to communicate information of this sort to aircraft in flight are being planned, and experimental installations are now in progress at Hadley Field and Bellefonte.

WEATHER SERVICE AND COMMUNICATIONS

The Weather Bureau of the Department of Agriculture has established during the fiscal year 22 new upper-air meteorological stations in addition to 15 existing ones, many of which are located at airports. Weather data collected throughout the United States are transmitted to Weather Bureau offices twice daily, and forecasts of flying conditions are made available to pilots taking off at all terminal fields.

A system of communication is being established under which the maintenance personnel on the airways will furnish to the Weather Bureau forecasters additional information regarding local storms, fogs, and weather changes. On the transcontinental airway 28 weather reporters were engaged in furnishing data to terminal fields on June 30, 1927. There are 17 radio stations on this airway, providing facilities for the transmission of weather information as well as information concerning the arrival and departure of planes from various terminal fields, the particulars of cargo and passengers carried, and emergency messages designed to facilitate and safeguard traffic. This system provides the fast communication which is essential in connection with air transport, and as rapidly as funds permit it is planned to extend it to all airways. At the present time weather information and essential messages are transmitted by telephone on all airways except the transcontinental.

ENGINEERING CONSTRUCTION AND MAINTENANCE

Airways established during the past year were surveyed and laid out by the survey branch of the section of extension and construction, the personnel employed consisting of licensed air pilots and engineers.

The airways follow the best flying country between designated airports, determined after a reconnaissance survey made by airplane flights. Intermediate landing fields averaging about 40 acres in extent are located about 30 miles apart between airports.

Experience of the past year has indicated that at sea-level elevation landing strips about 400 feet wide and not less than 1,800 feet long, are required on auxiliary fields, generally in two directions, giving four directions in which landings can be effected. Longer strips are necessary at higher altitudes to compensate for lessened air density and reduced engine efficiency. The majority of fields are L or T shaped. The surface should be fairly level, with clear approaches, and there must be good drainage. The fields should be located close to the highways to provide transportation facilities, and commercial power and telephone extensions are important considerations.

On a great number of fields in farming sections no grading or improvements to the land have been found necessary. In other sections, particularly in the West and Southeast, considerable grading and clearing of land is required. Where clearing and grading were needed the average cost per acre was $11 during the year.

The fields are licensed for from two to five years, but the licenses continue in force indefinitely, subject to six months' notice of removal, either by the owner or the Government. The average rental is from $8 to $10 an acre per year.

BEACONS

Beacon sites are located about 10 miles apart between intermediate fields. A plot 15 by 60 feet is required for each site, and the rental averages $25 a year. Where the flying terrain is bad, closer spacing of lights, and special lights marking buttes, obstructions, mountain passes, and other natural features are necessary.

The beacon towers are 50 feet high, of light galvanized structural steel, with a 6-foot square platform upon which a 24-inch standard

revolving beacon, 6 RPM, is mounted. The standard beacon, using a 1,000-watt T–20 electric lamp and 24-inch parabolic mirror, has a candlepower of 2,000,000. The lights are elevated 2° above the horizon. Where commercial electric power is available sun relays or astronomic clocks automatically control the light and no caretaker is needed. Otherwise a 2-kilowatt engine generator set is installed in a small power house. Part-time caretakers are employed to operate the beacon lights in these instances.

A concrete arrow is laid out at the base of the beacon tower pointing along the direction of the airway. Beacon numbers are painted on the power-house roof or the feather end of the concrete arrow, in black figures on a chrome yellow background.

INTERMEDIATE FIELD LIGHTING

A standard beacon is also installed at each intermediate landing field. The field is outlined with white boundary lights spaced about 300 feet apart, with green range lights showing the approaches to the field and red lights on all obstructions. Parkway cable is laid underground around the field for furnishing current to the boundary lights. The field is ground-marked for day flying with a white circle 50 feet in diameter and runway indicators 20 feet long by 2 feet wide at the intersection of runways showing the landing directions. In addition, corner strips show the extremities of the field. An internally lighted wind cone attached to a bracket on the side of the tower shows the wind direction.

Special equipment including towers, beacons, lamp-control apparatus, relays, engine generators, and wind cones are purchased by the Government and turned over to the general contractor for erection, this procedure being most advantageous, economical, and expeditious. The average cost of installing lighting facilities on an intermediate field is $5,500, and the average cost of the standard-airway beacon is $2,400.

MAINTENANCE OF AIRWAYS

The airways are maintained under the general supervision of the Lighthouse Service district offices. Each airway is divided into sections, each section being in charge of an airway mechanician who is held responsible for the maintenance and operation of his section. Transportation is provided by means of a 1¼ ton panel-body automobile truck equipped with all necessary spare parts and tools for taking care of practically any emergency repair job encountered. At the close of the year there were 31 airway mechanicians and 161 caretakers in charge of 4,121 miles of lighted airways, with 590 automatic acetylene and electric aids. Intermediate field equipment and airway beacons are serviced at least once each month.

IMPROVEMENT IN APPARATUS

Much was accomplished in the development of improved airway apparatus and structures during the year. The 24-inch rotating airway beacon has been improved by the addition of a flashing mechanism for identifying lights. The motor of the beacon is employed for the driving mechanism, thereby synchronizing the supplementary lights with the flash of the beacon. An improved and

reliable lamp exchanger for the beacons has been developed commercially. Airway structures have been numbered on a mileage basis for identification of location with respect to the airway. This numbering system has been incorporated in the lighting system in order that the distinctive characteristic may locate the beacon for the pilot aloft. The standard airway tower is now entirely suitable. A flashing electric beacon using a 360° Fresnel lens and top section showing from the horizon to the zenith, and so designed that equal candlepower is visible to the pilot approaching the light, is now being tried out at Beacon No. 6 on the Los Angeles-Salt Lake airway. Astronomic time clocks have been introduced for the control of automatic lights. Improvements have been made in the design of the internally lighted wind cone, making the device more reliable and eliminating the slip rings carrying current to the lights.

PROGRAM OF LIGHTING

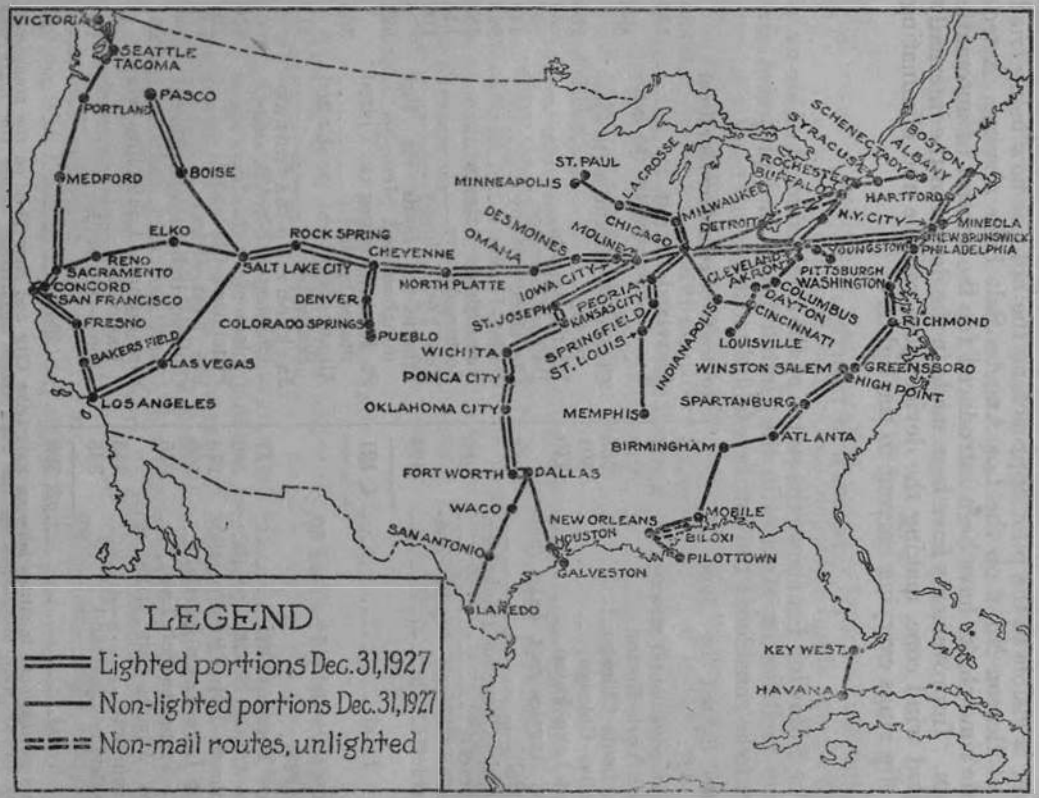
The following list shows the status of the establishment of air navigation facilities on airways in the United States and projected airways to be considered for future establishment:

Routes lighted by June 30, 1927:	Mileage
Transcontinental airway[1]	2, 041
New York-Boston	219
St. Louis-Chicago	268
Dallas-Chicago	501
Salt Lake-Pasco	110
Los Angeles-Salt Lake (partial)	288
Pueblo-Cheyenne (under contract)	200
Dallas-Chicago (under contract)	494
Total	4, 121

Routes to be lighted by June 30, 1928:	
New York-Atlanta	757
Los Angeles-Seattle (partial)	562
Chicago-Twin Cities (partial)	274
Salt Lake-Pasco (partial)[2]	500
San Francisco-Salt Lake	615
Los Angeles-Salt Lake (to complete)	345
Louisville-Cleveland	345
Total	3, 398

Routes to be considered for fiscal year 1929:	Mileage
Cleveland-Detroit	155
Los Angeles-Seattle (to complete)	590
Chicago-Twin Cities (to complete)	135
Miami-Atlanta	633
Dallas-Galveston	267
Cleveland-Albany	446
Dallas-Laredo	395
New Orleans-Atlanta	483
Boston-Albany	141
New York-Albany	160
Atlanta-St. Louis via Birmingham and Memphis	593
St. Paul-Winnipeg (to United States border)	365
Albany-Montreal (to United States border)	117
Jacksonville-Savannah-Charleston-Norfolk (seaplane airway)	810
Pittsburgh-Cleveland	121
Key West-Miami	128
Chicago-Indianapolis-Cincinnati	267
Birmingham-Louisville via Nashville	341
Tampa-Titusville	110
Total	6, 257

[1] The navigational facilities between Salt Lake City and New York on the transcontinental airway were established by the Post Office Department before the route was transferred to the Department of Commerce.
[2] Includes 110 miles of reconstruction.



Airway lighting program as of December 31, 1927

AIR INFORMATION DIVISION

The air information division is concerned with the collection and dissemination of information on civil aeronautics, domestic and foreign; the charting and publishing of information on airways, airports, and meteorological and other aids to flying; the encouragement of airport construction and other aids to navigation; the development of air commerce, including domestic and foreign trade in aircraft; and the general promotion of civil flight. The division is the point of contact between the activities of the department and the industry and all others interested. It is the fact-compiling and publishing agency of the aeronautics branch and the office for liaison with the information offices of other governmental bodies engaged in aeronautics.

INFORMATION BULLETINS

The division issues information bulletins on various subjects. Some of these are continuing series, brought up to date by corrected reissues. Among the bulletins already issued are the following:

Statement of Air Activities and Programs, Department of Commerce.
Airport Construction and Rating: 2 parts.
Trade Directory.
List of Aero Clubs.
Airports and Fields in the United States: List.
Short List of Air Publications, by subjects.
Map of United States Airways, continuously corrected.
The Airport and the City.
To-day's Air Commerce, a tabulation of airway operations.
Development of Air Transport.
Department Intermediate Fields, Requirements of.
Marking of Obstructions.
1926 Air Service Operations.
Aircraft Production, 1919–1926.
Government Departments in Aeronautics.
Aeronautics in Business.
Casualty Statistics (in course of compilation).
Air Traffic Rules, illustrated.
Aeronautics as a Vocation.
Compilation of State Air Laws.
Airway Statistics, 1926.
Airway Statistics, 1927 (first half).
Airplane Hangars.
Airmarking for Cities.

DOMESTIC AIR NEWS

A semimonthly publication is issued which furnishes news of the aeronautics branch, lists of pilots and planes licensed or planes identified, locations of new airports, traffic statistics, and other information of interest to the industry.

MAPPING

Under interdepartmental agreement, the air information division acts as a central agency for the sale of airway maps of the War and Navy Departments in addition to the airway maps produced by the Coast and Geodetic Survey.

The program of the Department of Commerce includes the production of 37 strip flight maps which, with the nearly completed 52-map program of the War Department, will cover all airways at present projected. The Hydrographic Office of the Navy has produced three of its planned 58 air charts along the Pacific and Atlantic coasts, the West Indies, Mexico (west coast), and Central

America. The maps to be produced under the department's program are as follows:

101. Galveston–Houston–Dallas.
102. Dallas–Oklahoma City.
103. Oklahoma City–Wichita.
104. Wichita–Kansas City.
105. Kansas City–Moline.[3]
106. Pilottown–New Orleans.
107. New Orleans–Jackson.
108. Jackson–Memphis.
109. Memphis–St. Louis.
110. St. Louis–Chicago.
111. Chicago–Milwaukee.
112. Milwaukee–Twin Cities.
113. Twin Cities–Fargo.
114. Cincinnati–Indianapolis–Chicago.
115. Cincinnati–Dayton–Cleveland.
116. Cleveland–Buffalo.
117. Milwaukee–Grand Rapids–Detroit.
118. Detroit–Buffalo.
119. Buffalo–Albany.
120. Albany–Boston.
121. New York–Albany.
122. Albany–Montreal.
123. Miami–West Palm Beach–Titusville.
124. Tampa–Titusville.
125. Titusville–Jacksonville.
126. Jacksonville–Atlanta.
127. Birmingham–Atlanta.
128. Atlanta–Greensboro.
129. Greensboro–Richmond.
130. Richmond–Washington.
131. Pueblo–Cheyenne.
132. Los Angeles–Las Vegas.
133. Las Vegas–Milford.
134. Milford–Salt Lake City.
135. Salt Lake City–Boise.
136. Boise–Pasco.
137. Pasco–Seattle.

The demand for maps on the part of commercial operators, individual flyers, industrial concerns employing airplanes for the travel of executives, and contestants in various events is constantly increasing.

CERTIFICATION OF LIGHTS

Air-navigation lights installed by private enterprise are certified and registered, and information concerning them published in bulletins. The private lights which have already been installed or are in project indicate the probability of a large number of these about the country on and off designated airways.

AIRWAY BULLETINS

Department of Commerce airway bulletins to the number of 112 have been printed and issued to pilots, manufacturers, and airports and others interested. These are illustrated loose-leaf sheets describing airports, Department of Commerce intermediate fields, and airways of the country; air marking, meteorological conditions; and other data necessary in air navigation. They have been published as fast as limited personnel would permit, the number of airports improved or newly constructed being at all times ahead of bulletin production.

AIRWAY MAPPING (COAST AND GEODETIC SURVEY)

The production of maps of civil air routes is assigned to the chart division of the Coast and Geodetic Survey, as an adjunct to its function of producing marine charts.

An effort is being made to produce accurate airway maps without special surveys. The maps are on a small scale (1:500,000). The aviator does not require a high degree of accuracy with respect to a multitude of minute details which would escape his attention during his rapid flight over the country. He does, however, require accu-

[3] Only one of series completed June 30, 1927.

racy in the major features. Highways, railroads, and streams must be shown in their proper relation to each other. If a highway is shown on the wrong side of a railroad, it sooner or later will make trouble for the aviator. Again, it is not enough merely to show a power-transmission line following a road. The pilot must know at all times on which side of the road the line is located, as otherwise, flying low in thick weather in order to follow the road as a guide, he might collide with the line. These and other similar items require the most careful attention of the map compiler as the value of the map and the safety with which it can be used depend directly on the accuracy with which such features are shown.

The information used in the production of airway maps is derived from a variety of sources, such as the State maps and quadrangles of the Geological Survey, the post-route maps, highway maps of the Bureau of Public Roads, State and county maps, commercial publications, and, finally, a large amount of miscellaneous information secured from corporations or individuals operating aircraft, and Army, Navy, and civilian pilots. After information from these sources has been compiled it is necessary to verify the compilation by actual observation on the route. Although this may be accomplished in part by flight check, it is believed that it will prove more satisfactory to send qualified engineers over the terrain by automobile to indicate, after inspection, the corrections necessary to make the map accurate and reliable for flight purposes. The 1928 mapping program contemplates work of this character.

Four men were added to the personnel of the chart division during the fiscal year 1927 for work on airway maps. With this force four months is required for the production of one map. The personnel will be enlarged during the coming year.

During 1927 one map (from Kansas City to Moline) was completed. Five others were partially completed and are now ready for flight check. It is expected that by the close of the fiscal year 1928 maps of the following routes will be wholly or partially completed, and at least three will be available for distribution:

102. Dallas–Oklahoma City.
103. Oklahoma City–Wichita.
104. Wichita–Kansas City.
110. St. Louis–Chicago.
111. Chicago–Milwaukee.
112. Milwaukee–Twin Cities.
128. Atlanta–Greensboro.
129. Greensboro–Richmond.
131. Pueblo–Cheyenne.
134. Milford–Salt Lake City.

AERONAUTICAL RESEARCH DIVISION (BUREAU OF STANDARDS)

Of the research and experimental work contemplated by the air commerce act, two fundamental problems were taken up by the Bureau of Standards during the fiscal year 1927, first, the development of radio aids to air navigation, and, second, the improvement of lighting facilities.

RADIO AIDS

Active work on the aeronautical radio problems was started at the Bureau of Standards July 1, 1926. Arrangements having been completed for the lease of the former air mail field at College Park, Md., and one hangar, contracts were awarded for the construction of a

wooden tower and house for a directive radiobeacon and an office, storeroom, and radio room in the hangar building.

These housing facilities were completed in October. Meanwhile equipment for the beacon was being accumulated and orders were placed for needed supplies. A DH airplane, a 1-kilowatt radiotelephone transmitting set, and several other useful items were transferred from the Post Office Department.

By December installation of the equipment of the first model of directive radiobeacon was completed and initial tests made. The technical members of the staff completed their first studies made toward a solution of the problem of a visual indicator for airplane use to be employed with the directive beacon.

Much time was consumed in getting organized. The bureau undertook the project without any equipment, air field, or airplane. By December, 1926, most of these essentials had been provided and test flights were being made with the first model visual indicator and a new type directive radiobeacon transmitter. The first experiments indicated that the visual system had possibilities and also that the course was likely to be sharper and more easily flown than with the aural system already in use by the War Department at McCook Field. A small marker beacon was also constructed at College Park during the period.

To enable radiotelephone communications to and from the airplane to be carried on, a loan of the former WCAP station at Washington was secured from the American Telephone & Telegraph Co., who also generously provided suitable control lines between that station and College Park, as well as to the Bureau of Standards and the Department of Commerce.

The success attained with the College Park installation determined the bureau to undertake the construction of another similar unit at a point on the transcontinental air mail route. The Bellefonte, Pa., air field was selected in cooperation with the Post Office Department as the most useful location for this purpose because of the unfavorable flying weather conditions in that region, and the work on this project was initiated in March, 1927.

On June 30 the Bellefonte radiobeacon station was in operation, a Post Office Douglas airplane made ready to be equipped with radio apparatus, and all materials needed for the radiotelephone transmitting set delivered to the site. A former Post Office radio station consisting of two 100-foot masts and a two-room building was rehabilitated for use as a remotely controlled transmitting station.

In May, 1927, the bureau exhibited the directive radiobeacon and radiotelephony to and from airplanes at the All-American Air Display held at Washington. Following this an experimental flight was made from Washington to Detroit, telephonic communication being maintained with Washington for 100 miles. In June the bureau equipped an airplane which broadcasted the events of the arrival of Colonel Lindbergh at Washington. A triple-engined all-metal monoplane was lent through the courtesy of the Ford Motor Co. for these flights.

As a result of the work at College Park the Bureau of Standards feels that three items of its aeronautical radio program, namely, the directive radiobeacon with visual indicator, radiotelephony to air-

planes, and the radio marker beacon, are ready for actual trial in daily use on an airway. While the visual indicator problem has not been satisfactorily solved, much progress has been made.

At the conclusion of the year the bureau finds itself ready with a completely equipped field laboratory and airplane at College Park, where development work is under way, and a complete experimental unit and airplane at Bellefonte, Pa., where service tests can be conducted over the New York-Cleveland section of the transcontinental air mail route.

Members of the staff have visited other agencies interested in these projects, such as the General Electric Co., the Ford Motor Co., and the Air and Signal Corps laboratories at Dayton. Contact has also been maintained with several of the air mail contractors interested in the project.

LIGHTING

Experimental work in the lighting of airways was begun on September 1, 1926. A study has been made of the literature on airway and landing-field lighting, and a report has been prepared on the use of neon lamps for such purposes.

Experimental work has been carried out with a lighthouse lens furnished by the Bureau of Lighthouses, which was mounted on an automobile chassis for use in measurements at College Park field. Through the courtesy of the General Electric Co. a 10,000-watt lamp was furnished for use with this lens.

Conferences were held with aviators, Army and Navy engineers, manufacturers of equipment, and consulting engineers as a basis for outlining a program of experimental work.

Laboratory experiments were made on two neon lamps. A parabolic reflector was designed and made for use with these lamps, and was found to increase the candlepower about 10 times. Field tests showed that over a range of about 2 miles the bare lamp was scarcely visible, but that it was plainly visible with the reflector. The lamp was not visible at night during heavy fog and rain.

Flying tests were made at the Naval Air Station, using Sperry landing flood lights, compared with B. B. T. flood-lighting equipment. Photometric data were determined on both of these systems.

A series of computations and curves have been made, showing the distribution of candlepower in a vertical plane required to give equal visibility at stated distances from an airplane flying at fixed altitudes.

THE 1928 RESEARCH PROGRAM

During the coming year work will be continued looking to the perfection of the radiodirective beacon and field-marker beacons and the further development of telephone communication between airplanes and the ground. It is expected also to take up a number of new problems, including a study of the distribution of the light from beacons and the relation of light color to effectiveness, an investigation of the strength of airplane joints and fittings of standard design, an investigation of the stability of planes of different types, and studies of methods of reducing airplane noises.

II. DEVELOPMENT OF CIVIL AERONAUTICS

America is doing a prodigious amount of civil flying. It may generally be divided into three classes: *Air transport*—scheduled operations over regular routes (mail, express, and passenger); *commercial air service*—such as "taxi" service, crop dusting and spraying, photography, over-city rides, tours, and so on; and *private flying*—including pleasure aviation and the travel of business men using airplanes in their daily affairs.

AIR TRANSPORT

To the surplus of aircraft at the conclusion of the war, and the experience in the carrying of messages, mail, and personnel by air during the war, may probably be ascribed the inauguration in Europe in 1919 of an airway system which has now been extended to cover Central Europe and reaches into Africa, Asia, and the far corners of the world.

A great passenger and express business has been developed in addition to air mail. The routes are supported in the main by subsidies, direct or indirect, amounting to a great sum annually. Many of these routes serve colonial possessions without regard to purely civil or commercial reasons.

DEVELOPMENT OF AIRWAYS IN AMERICA

As in Europe, prior to the World War no mail, passenger, or express air routes were continuously operating in the United States save for some seasonal short lines operated spasmodically and for occasional brief demonstrations in cooperation with the Post Office Department at air meets and exhibitions.

For a brief period in 1918 an experimental air-mail route was operated by the Post Office Department between New York and Washington, D. C.

In 1919 the Post Office Department initiated the transcontinental air mail route between New York, Chicago, and San Francisco. The operation of planes between Cleveland and Chicago was begun on May 15. On July 1 the operations were extended from Cleveland to New York.

Beginning May 15, 1920, the line was extended west from Chicago to Omaha, and on September 8, 1920, flying began between Omaha and San Francisco, completing combination daylight airplane and night train service across the continent. The mail was flown out of New York and put on a train in the evening at Chicago, taken off the train the following morning and flown the remainder of the route.

A route from St. Louis to Minneapolis-St. Paul was operated by the Post Office Department between December 1, 1920, and June 30, 1921.

FIRST CONTRACT ROUTES

On October 15, 1920, foreign-mail contract routes were inaugurated between Seattle and Victoria in the northwest and between Key West

and Habana in the southeast. The Seattle-Victoria route still continues operation. The Florida route was discontinued March 31, 1923, to be resumed in 1927.

Another foreign contract air-mail route began operation April 9, 1923, between New Orleans and Pilottown. The Seattle and New Orleans routes carry 2-cent mail to and from steamers and save many days.

A contract route was also operated between Fairbanks and McGrath, Alaska, from February 1 to June 30, 1924.

FIRST NIGHT SERVICE

On July 1, 1924, night flying began between Chicago and Cheyenne, this portion of the transcontinental route having been lighted by the Post Office Department. Subsequently lights were added between Chicago and New York to the east, and between Cheyenne and Salt Lake City to the west.

TO-DAY'S AIR ROUTES

As a result of the air mail act of February 2, 1925, with amendments, there has rapidly developed a great contract air-mail system, the nucleus of the now growing air-transportation net.

On January 1, 1926, the Post Office Department had the transcontinental mail route in operation both ways between San Francisco and New York, with an additional night service both ways between Chicago and New York; and the two foreign contract routes out of Seattle and New Orleans.

At various dates, beginning February 15, 1926, nine other contract routes were put into operation, and on June 30, 1926, the airway system consisted of 12 routes.

During the second half of the calendar year 1926 other routes were added and the Post Office Department advertised the transcontinental and New York-Chicago overnight routes for private operation. The contract for the section from Chicago to San Francisco (daily) was let to the Boeing Air Transport and for the section between Chicago and New York to the National Air Transport (daily and nightly). The Boeing company began operation July 1, 1927, and the National Air Transport was scheduled to begin September 1, 1927.

There were 55 station stops on the routes in operation on June 30, 1926. Over $5,000,000 was invested in the contract airway system by the air-mail contractors in the calendar year 1926, and this sum was rapidly increased as new routes and new vehicles were added.

By the end of the calendar year 1926, 18 routes had been operated for mail or passengers, or both, and freight.

Save for that portion of the Government's route between Salt Lake City and New York, lighted by the Post Office Department, all civil airway flying before July 1, 1926, was done without lighting facilities. The economical use of the airplane demands flying by night as well as by day and in all vicissitudes of weather and season, and it is the purpose of the Department of Commerce, under the air commerce act of 1926, to furnish to air traffic those aids which will result in the

greatest degree of flight efficiency. Lighting of the airways was undertaken immediately upon the organization of the aeronautics branch in the fall of 1926, and before the end of the calendar year 1926 some lights were already placed in operation. On June 30, 1927, there were 4,121 miles of lighted airways, including the 2,041 miles on the transcontinental airway which had been lighted by the Post Office Department.

On July 1, 1927, there were 15 mail lines in operation and 9 more advertised for bids. In addition there were 3 nonmail routes. The 24 mail routes will serve 65,677,209 people in the various trading areas along these airways, with 75 station stops.

COMMERCIAL AIR SERVICE

By far the greatest volume of flying in America has been done by fixed-base and itinerant air-service operators—individuals, firms, and corporations engaged in taxi service, crop dusting, journalism, and news photography, sight-seeing, commercial photography and mapping, touring, flying instruction and other miscellaneous pursuits—utilizing light commercial planes of both new and war-surplus materials.

This class of operators has no parallel in any other country. The itinerant pilots have become fixed-base operators and this phase of commercial flying has settled down into solid business.

To the Post Office Department and air-service operators belong the credit for keeping flight before the public during the whole postwar period. Their pilots flew nearly 19,000,000 miles in 1926, according to the department's estimates.

PRIVATE FLYING

Unexpected purchasers at this comparatively early stage of general flight are the corporations and individual business men who have bought the most modern airplanes for business travel. Corporations, particularly, have put into service the largest cabin planes with triple engines.

There remains the sport and pleasure use of aircraft—private flying. This is developing very rapidly, and thousands of private owners will soon fly for pleasure in up-to-date, modern, inherently stable aircraft at a reasonable cost. Comparatively low-priced airplanes of new design and construction are now available and are quickly replacing the many war-surplus types that have been serving until the present time. Manufacturing and the development of additional aircraft will continue on an ever-increasing scale, and it is difficult even to venture a guess as to the limitations on this class of flying.

GOVERNMENT PARTICIPATION

The safe and continued development of all classes of operations depend largely upon the airworthiness of the aircraft employed, the competency of pilots, the establishment and maintenance of properly equipped airways, the enforcement of standard air traffic rules, and an adequate dissemination of information concerning facilities on airways and at airports. It is in these matters that the Government must render a very definite and comprehensive service.

AIRPORTS AND LANDING FIELDS

The inauguration of contract mail and other routes forced the establishment of new airports or the improvement of existing airdromes at every station stop along airways by the municipalities—either directly by the city or in its behalf by civic organizations, or by private enterprise.

Everywhere civic interest has been stirred by the progress of air transport, and cities all over the country, both on and off the airways, are working with the airport idea toward varying degrees of airport excellence. These airport facilities may be rated under the act. The value of the land and improvements varies greatly, running as high as $1,000,000 or more at the larger ports.

At the close of the fiscal year 1927 there were recorded 864 municipal, commercial, or private airports, intermediate fields maintained by the Department of Commerce and unimproved but permanent landing fields, a great many of which were reconstructed or proposed for development in accordance with the standards suggested by the department.

In addition, airports of one grade or another were under discussion in 144 cities, with the number growing. It is estimated that about 1,000 airports will be in operation at the end of the fiscal year 1928. Of these a large portion will be municipal.

DEPARTMENTAL COOPERATION

Illustrated descriptive bulletins are published by the department on all airports as fast as conditions permit. The entire country is under a first annual canvass of unimproved auxiliary fields, of which there were approximately 3,000. A register of these is maintained for flights off scheduled routes.

The development of airports has been directly aided by the Department of Commerce through its Airport Bulletin and other publications. The bulletin covers, with illustrations, practically every subject connected with the construction and equipment of an airport. Some 4,000 copies have gone to cities, commercial organizations, engineers, editors, and others directly interested in airport development.

Personal advice and aid in the establishment of airports and the construction of terminal facilities have been given in scores of cities by the assistant secretary for aeronautics or the personnel of his office, while every imaginable phase of the subject has been covered by voluminous correspondence.

Representatives of the department have encouraged airport development in a great flying circuit of the country made in cooperation with the Daniel Guggenheim foundation. Commander Byrd's polar airplane carried his transpolar companion, Floyd Bennett, with a representative of the department to 45 cities in an 8,604-mile tour.

In a circuit of some 80 cities with Maj. H. A. Dargue, commander of the Army Air Corps' Pan-American "Good will tour," Walter O. Lochner, secretary of the National Association of Commercial Organization Secretaries, carried letters from the Assistant Secretary for Aeronautics urging the various commercial organizations of the

country to interest their communities in the development of aeronautics and the establishment of airports. A representative of the aeronautics branch made a tour of all the cities along the existing air mail routes, using various forms of transportation—air, rail, and motor. The primary purpose of the tour was to stimulate the use of the air mail, but the entire field of civil aeronautics received attention. Comments from business men and municipal and chamber of commerce officials indicated that this tour was very beneficial.

AIR MARKING OF CITIES

Thousands of cities are being air marked. During the year one oil company painted city names on most of its 4,200 stations in 10 States, and four other concerns are similarly marking towns in other States.

As the year closed the support of the governors of all States was enlisted in urging civic associations to push the program of marking. Every such organization has been furnished with uniform specifications as to size and colors.

A standard system of distinctive marking of obstructions, such as high tension power lines, radio towers, and similar obstructions, was drafted by an interdepartmental committee and is the subject of another department bulletin.

EQUIPMENT-DESIGN PROGRESS

The passenger-service airplane of to-day is so far advanced that it is difficult to realize that scheduled air transport service as we now know it is less than two years old.

We are still prone to think of the passenger airplane as the two-seated, open-cockpit affair of war and postwar days.

Heretofore the designer has been almost entirely engrossed with wing and power loading curves and resistance—flight efficiency along the particular line demanded.

Now, however, attention is being given to comfort and equipment. To-day one steps into a cabin-type aircraft, takes a comfortable upholstered seat with ample leg room, and deports himself in the same manner as in a closed automobile of the most modern construction.

The closed airplane has developed far more rapidly than the closed automobile. The leather coat, the helmet, and the various paraphernalia of the air traveler of yesterday have disappeared. Even the pilot of the modern passenger plane is inclosed in a comfortable, heated cabin with sliding or hinged glass windows, which may be opened for ventilation or for better visibility. The question of comfort is being given ever more serious consideration.

Into the plane itself has been built the inherent stability promised for a quarter century. Yet sacrifice has not been made of maneuverability and controllability.

One of the most striking features of late development has been the general application of brakes to airplane wheels, by which the landing roll is greatly reduced. Brakes on either wheel are independent in action so that they can be used for maneuvering on the ground.

Oleo pneumatic and oleo spring gears are being widely adopted for shock-absorption purposes on the landing gear and have proved very successful in improving landing characteristics.

In the design of the fuselage, wood and wire construction have been almost entirely superseded by welded steel tubing or other metal construction. Wings continue to be largely built of wood spars and ribs with fabric covering. Several manufacturers have, however, given attention to the construction of all-metal planes of duraluminum with a very thin sheet of the same material replacing the fabric, and more than one such design is in commercial use.

In general airplane design there is a tendency to revert to the monoplane which was used so extensively in early days of aviation. The visibility for both pilot and passengers is greatly improved over that of the multiplane type, and for the present demands upon commercial planes, monoplane construction presents no unusual problems for the manufacturer.

The weight of the power plant per horsepower has been materially reduced, and one of the newest engines has reduced the frontal area some 30 per cent. Improved propellers at the same engine speed in the identical airplane give greater efficiency. The air-cooled engine is being extensively used for commercial purposes because of its light weight, simplicity of installation, and reliability.

In the installation of the engine considerable attention is being given to exhaust manifolds which both reduce the noise of the engine and carry the exhaust gases clear of the passenger compartment.

Air-pressure systems for the gasoline supply have been almost entirely replaced by gear-driven pumps and gravity, and one of the greatest hazards—that of fire—has thus been practically eliminated.

The cargo space of two or three years ago was 50 to 60 cubic feet for approximately 1,000 pounds of useful load with 400 horsepower. Now, we find many planes of 200 horsepower with a similar load capacity and double the cargo space, and at the same or better speed. The cause is found in the greater efficiency in design and construction of both aircraft and engines.

With the same assurance offered by train, air service now furnishes a 10-hour schedule between New York and Chicago; 30 hours to the Golden Gate; and overnight to Florida. This illustrates the speed of air transportation, undoubtedly the greatest advantage this vehicle offers. Night flying will increase as fast as the department is able to install the lights along the airways.

The cost of air-transport operation is yet a problem, but it is being rapidly overcome as the volume of business increases. Many of the commercial companies now, while being obliged to maintain a complete overhead, are operating at only a fraction of cargo capacity. This situation will adjust itself and the costs will be more efficiently distributed. The differential in speed, however, between air travel and other methods of transportation is important and must be taken into account when determining comparative costs. The cost of air transport to the traveler is surprisingly low when the time element is considered.

WEATHER AND FLIGHT

Though the airplane in emergency is often the sole means of communication, yet its operations in scheduled daily service are affected to some extent by weather, practically the only hindrance to perfect performance.

Of the 5,272 trips scheduled on civil airways during the first half of 1927, 623 of the 685 trips which were defaulted were chargeable to bad weather.

The difficulty of night flying is being rapidly overcome by lighting and other aids to navigation.

Of all weather conditions described as bad, fog presents the greatest hazard. Research and experimental work is being conducted at the Bureau of Standards to overcome this, however, by the development of suitable navigation instruments. An unofficial committee organized by the Guggenheim Fund for the Promotion of Aeronuatics, which includes representatives of various Government bureaus, is likewise endeavoring to further research in the elimination of fog as a prohibitive of flight.

AIR ACCIDENTS

Under the air commerce act accidents are required to be investigated and reported, and the department is now performing this function.

CASUALTIES IN AIRWAY FLYING

Casualties in scheduled airway flying are comparatively rare.

In 1926 the Government-operated transcontinental suffered one pilot fatality. One occurred during the first half of the calendar year 1927. Weather conditions were responsible for one of these accidents. The exact cause of the other is unknown.

On the contract routes there were three pilot fatalities and one passenger fatality in 1926. Three accidents were ascribed to weather. One was of undetermined cause. During the first half of the calendar year 1927 there were two pilot and one passenger fatalities, in two accidents, both chargeable to weather.

Pilot examinations, plane inspections, and the lighting, weather service, and other aids to airway flying, now installed or in the department's program, should practically eliminate accidents in scheduled flying.

CASUALTIES IN MISCELLANEOUS FLYING

In air service operations and miscellaneous flying it is expected that casualties will be more frequent; but here, also, the enforcement of precautionary measures and the utilization of the Government's facilities will decrease the casualty rate.

During the last half of the fiscal year 1927, 15 pilots and 28 passengers were killed in 25 airplane accidents in this country. These accidents occurred in course of "taxi" service and pleasure rides, test flights, and instruction. Thirteen of the accidents were ascribed to error in pilotage, 3 to power-plant failure, 2 to weather, and 7 to structural failure. Practically all these accidents occurred with unlicensed pilots and in unlicensed planes.

AIRCRAFT PRODUCTION AND TRADE

The aircraft industry is in the position of being far behind on orders. It is reasonably expected that the production of airplanes during the calendar year 1927 will at least double that of 1926. Even this may be too moderate an estimate.

In a special count made by the Bureau of the Census in cooperation with the aeronautics branch of the department, the 1926 output of

the manufacturing industry was 1,186 planes valued at $8,871,027 as against 789 in 1925 with a valuation of $6,673,659.

The military services, the Department of Agriculture, and the Post Office Department took 328 of the 1926 planes, and 50 were exported, leaving 808 as the minimum civil consumption. In addition, air-service operators produced approximately 150 planes.

The total value of work done in 1926 by establishments engaged primarily in the manufacture of airplanes was $24,161,752, including the value of airplane engines, amounting to $4,080,571, made by establishments engaged primarily in the manufacture of such engines. The total value of products reported for 1926 by establishments in the aircraft industry proper is $20,081,181, as compared with $12,524,719 for 1925, an increase of 60.3 per cent.

It might be said that the present civil demand represents but the initial production of a new industry. Civil aeronautics has, in the main, been operating on war surplus. The demand for modern planes, the diminution of war supply, the development of better engines, and the application of Federal inspection, combined with the widespread acceptance of the airplane in business promise an increase of which any estimate must be but a guess.

EXPORTS

During the calendar year 1926 the total value of United States exports of aircraft, aeronautical engines, and parts for planes increased satisfactorily over those of 1925. Specifically, they increased $243,551 over the 1925 total of $783,659, showing a valuation of over $1,000,000. This is very encouraging in view of the number of sales made in Latin America by European companies during the past year, American manufacturers finding their prices very difficult to meet due to European currency depreciation.

The record of the first half of 1927 forecasts another increase for the full year.

The greater part of the increase in exports was registered in aircraft engines, the number of units showing an increase from 73, valued at $170,793, in 1925 to 297, with a valuation of $573,732, in 1926. However, the average engine unit value decreased 14.5 per cent during the same period, indicating that a much greater percentage of salvage types was exported in the latter year.

The number of planes exported decreased from 80 to 50 units during the same period. Here again the unit value decreased somewhat, as the 1925 exports of planes were valued at $511,282, while the value of exported planes fell to $303,149 in 1926. Airplane parts showed an increase of nearly 50 per cent, from a valuation of $101,584 in 1925 to $150,329 in 1926.

The United Kingdom was our leading market for aircraft products in 1926, taking $281,050 of the total. Soviet Russia was second, our exports to that country totaling $270,739; Peru was third, with $120,231; Mexico fourth, with $85,459; and Canada fifth, with $47,276.

For the first half of 1927 exports of airplanes decreased from 26 units for the same period in 1926 to 19, but the unit value increased from $4,729 to $16,400, indicating purchases of modern, new planes. Latin America was our leading market with a total of $239,919.

Engine exports in 1927 show a decline both in number and value, when contrasted with the same period of 1926. However, the situation is not discouraging, as with a few exceptions exports of aircraft engines consisted of new engines of relatively high unit value. The wide distribution of these exports would indicate also that the majority were experimental orders. The low unit value of $1,795 in 1927 is accounted for by the fact that 53 engines, with an average unit value of $456, were exported to Canada. Of the remainder, 13 engines had an average valuation of $7,572 each.

The export value of aircraft parts during the first six months of 1927 was almost 100 per cent higher than during the same period of 1926. One-third of the total during the present calendar year has gone to Canada. Furthermore, the exports of parts to Canada during the first six months of the year far exceeded the total exports of aircraft, engines, and parts to that country during the entire calendar year 1926. Soviet Russia in Europe and the United Kingdom also loomed up relatively large as export markets for aircraft parts during the present year, as did Chile in the Western Hemisphere.

TRADE PROMOTION

In early May the department initiated the national aircraft show and flight demonstration at Bolling Field during the annual convention of the United States Chamber of Commerce and the sessions of the Pan-American Commercial Conference and the Inter-American Air Commission. The business men of North and South America and a number of American railroad executives were shown a great many of the latest types of civil and military aircraft, with all air-navigation accessories, and more than a thousand visitors were given flights. This was the most comprehensive aeronautical display ever held in this country and gave evidence of the security of aeronautics as a business.

During the year the first directory of the industry was compiled in the department. It has run through several editions and is constantly being enlarged. It lists 900 firms, corporations, or individuals engaged in different phases of the aeronautical industry.

III. CONCLUSION

AIM OF THE AERONAUTICS BRANCH

It is the aim of the Department of Commerce to assist in bringing about a combination of four elements which are considered essential to the success of civil aeronautics in this country: (1) Airworthy aircraft, adequately equipped and efficiently maintained, and (2) flown by competent pilots over (3) suitably equipped airways (4) in conformity with standard air-traffic rules. When this has been accomplished the public will take air transport for granted, as it does the railroad, the steamship, and the automobile.

Very truly yours,

CLARENCE M. YOUNG,
Director of Aeronautics.

RADIO DIVISION

DEPARTMENT OF COMMERCE,
RADIO DIVISION,
Washington, July 1, 1927.

Hon. HERBERT HOOVER,
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 year, including references to related developments which have taken place during the year.

Because of the rapid advances in the field of broadcasting several efforts have been made during the past few years to obtain new legislation providing adequate control.

Congress passed the original law entitled "An act to regulate radio communication" in 1912. No difficulty arose in connection with the enforcement of this act until the advent of broadcasting. When Congress passed this law radio broadcasting was unknown, consequently no special provision for the control of broadcasting was embodied in the act. For a time orderly operation was made possible by calling together the interested parties and getting them into agreement on the basis of self-regulation. Finally an adverse court decision indicated the advisability of obtaining an opinion of the Attorney General with reference to the authority conferred upon the Secretary by this act. The Attorney General rendered an opinion under date of July 8, 1926, to the effect that the Secretary of Commerce was without authority, under existing law, to assign wave lengths, limit the power, or fix the hours of operation of radio stations. The Attorney General held, moreover, that the Secretary was without authority to refuse a license for the operation of a radio station. This brought about a chaotic situation. All applicants were granted licenses under which they made use of such wave lengths and power and at such times as they saw fit. It became evident that confusion would continue and grow worse unless remedied by legislation. Congress, therefore, passed the radio act of 1927, repealing the act of 1912. Under the new law, which became effective February 23, 1927, a Federal Radio Commission of five members was created. The commission has full authority to license stations for one year. It determines to whom licenses shall be granted and fixes wave lengths, power, and hours of operation. The general powers of the commission are transferred to the Secretary of Commerce from and after one year after its first meeting, which was held on March 15, 1927, the commission retaining authority over certain controversial matters which may be referred to it.

CREATION OF THE RADIO DIVISION

Enforcement of the radio laws has been under the jurisdiction of the Bureau of Navigation since July 1, 1911, when the act requiring apparatus and operators for radio communication on ocean steamers

became effective. The extension of the use of radio to general communication purposes, broadcasting, transmission of photographs, etc., made it inadvisable to continue the work in a bureau whose primary concern was the enforcement of laws relating to shipping. It was accordingly decided to separate the radio service from the Bureau of Navigation, effective February 26, 1927.

RADIO INSPECTION SERVICE

During the fiscal year just ended, 9,330 inspections were made of the radio installations on American and foreign vessels clearing from our ports, as compared with 9,197 the previous year. These inspections developed 285 cases of defective apparatus, lack of proper equipment or personnel, or other causes which would have constituted violations of the law had the vessels sailed without inspection. Examinations were given to 3,328 applicants for commercial operators' licenses and 5,597 applicants for amateur operators' licenses. There was a decrease in the number of inspection trips made and the number of land stations inspected due to the lack of control which developed as a result of the previously mentioned Attorney General's opinion. Since the new law became effective our activity has been resumed, with increased demands made upon this division for inspections, observations, monitoring, and special investigations. Many such services are required by the Federal Radio Commission. The radio division is performing all of the field work for the commission, but finds it difficult satisfactorily to meet the demands made upon it even to a limited degree. An enlarged personnel and better equipment are essential for the proper performance of this work.

RADIO TEST CARS

With the rapid progress in radio communication the necessary testing apparatus increased to such an extent that it was no longer possible for an inspector to carry all of the delicate measuring equipment required to make the inspections prescribed by law. To solve the problem, an automobile chassis was selected upon which was mounted a special body capable of housing complete inspection apparatus. On October 7, 1925, the first radio test car was placed in active operation in the field. On this car was permanently mounted a complete radio direction finder, to take bearings on unlicensed transmitting stations, and several sensitive radio receivers by the use of which it was possible to measure the frequency on which transmitting stations were operating. A radio field intensity set was installed in the car, and with this piece of apparatus it was possible to determine the external effect produced by a radio transmitting station in the area in which it was located. Equipped in this manner, the first radio test car operated by the Department of Commerce went into commission in a form which has been found so thoroughly practical that very few changes would be necessary in new cars of this type. It was found that considerable economy in transportation and subsistence in the field could be effected by the use of radio test cars.

The operation of the first test car indicated the advisability of procuring additional cars in order to cover more territory and perform duties not possible of accomplishment in any other manner.

Improvements in the interior arrangement of the cars and the apparatus mounted therein were embodied in the specifications drawn for the three new test cars in February of this year. One of the principal improvements in the apparatus was the incorporation of a number of the individual pieces of equipment for the measurement of frequencies or field strength into one compact unit. With this piece of equipment it is possible to determine the field strength of transmitting stations at distant points operating on wave lengths from 50 to 600 meters and with the same apparatus it is also possible accurately to check the frequencies of transmitting stations operating on wave lengths from 50 to 1,250 meters. It is contemplated that in the near future apparatus will be developed for properly measuring frequencies below 50 meters, which is considered essential, in addition to the present equipment of these cars. The use of the lower wave lengths or higher frequencies is rapidly becoming more general.

In addition to the measurement of frequencies and field strength indicated above, space is provided for the examination of applicants for radio operator's licenses. Each radio test car is in reality a portable laboratory and inspection office.

The three new test cars referred to above, fully equipped, will be placed in active operation in the early fall of this year.

FIELD STRENGTH MEASUREMENT

At the Third National Radio Conference the Secretary of Commerce suggested an investigation on the effect on radio reception produced by broadcasting stations of different power to find out why reception was better in one direction and poorer in another and why some stations of equal power did not serve equal areas.

Since this time the supervisor of radio at Detroit has been experimenting with methods of making these measurements. The results of six investigations made by the supervisor are contained in the March issue of the Radio Service Bulletin.

It has always been the practice to rate radio transmitting stations in terms of power supplied to the antenna. Such a method does not indicate what the effect produced on a distant radio receiver will be. Stations of equal power do not produce signals of equal intensity over the same area. It has been proven that this is due to absorption of the radio energy by steel buildings, electrical networks, or other large metallic bodies.

These stations may be made to serve equal areas if the method of measuring their power is changed. The power has always been measured in the amount of watts or kilowatts in the antenna. A suggested method of measuring power is in microvolts per meter at certain distances from the transmitter.

From the data gathered on a field-strength study of a station it is possible to make a map showing the exact area covered. On this map can be shown the strength of the radio field in microvolts at varying distances from the transmitter. With such a system of measurement any change of power in a station could be determined anywhere in the area served.

FREQUENCY STABILITY

The necessity for maintaining frequency stability is becoming more and more important because of the increasing number of high-range stations. The demands made upon our service to insure the required accuracy necessitates the use of the most modern and precise measuring apparatus available. Our apparatus must be as accurate and dependable as the best used by commercial interests. Public confidence must be maintained in the accuracy of the measurements made by the radio inspection force. Our instruments and methods must be accepted as standard.

RADIO COMPASS

The value of a radio compass as an aid to navigation is indicated by the increased installations. There are now 541 American vessels equipped with radio compasses. Last year there were 230. A good percentage of these installations are on vessels on the Great Lakes.

TUBE TRANSMITTERS

There is a continued growth in the use of tube transmitters. Most of the larger vessels which enter our ports make use of this type of equipment, with the advantage of long-range communication and reduction of interference. Most of the stations on land make use of tube or arc transmitters. Spark transmitters are used principally in Alaska. All of the transoceanic services utilize continuous-wave transmitters.

PHOTOGRAPHS BY RADIO

The sending of photographs by radio has been in course of development for several years. A service making use of one of the systems provides for the transmission of weather maps from the United States Weather Bureau to vessels at sea, where they are recorded with pen and ink on base maps. Another service referred to commercially as "Photoradio" was opened to the public on a commercial-rate basis on May 1, 1926. An important extension of this service which promises to be of public interest and benefit is in the nature of facsimile reproductions, whereby a radio message handed in at the transmission station is exactly reproduced at the receiving station and so delivered to the addressee. With this system it is possible to transmit messages written in hieroglyphics, shorthand notes, fingerprints, etc.

TELEVISION

"Television" is a name given to a new system which is old in some of its principles. So far it is considered experimental in its association with radio. Several successful demonstrations of its use have been given. One of these demonstrations, which took place on April 7, 1927, required the use of three transmitters, one being of 50 kilowatts power employed to transmit the speech of the person talking, one of 5 kilowatts power used for the transmission of the picture of the person talking, and the third of 1 kilowatt power to generate

a current for the purpose of synchronizing the frequency of the picture and voice transmitters. This arrangement made possible the reception of voice and picture simultaneously.

AMATEUR SERVICE

During the past fiscal year the number of amateur transmitting stations increased from 14,902 to 16,926. Much credit is due to the amateurs for their contribution to the development of short-wave transmission. Nearly all of the amateur stations are now operating on wave lengths of 80 meters and below.

It seems appropriate to mention briefly here some of the more important public services rendered by amateur stations during the past year. Immediately following the Florida hurricane many amateur stations in Georgia, Florida, Alabama, Mississippi, and Louisiana provided the only means of communication with the stricken sections. They handled important and urgent messages between the State and municipal authorities, messages for the Red Cross consisting of requests for food, medical supplies, and doctors. Much of the same service was performed during the Mississippi flood. For the past three years the American Radio Relay League, through the American Railway Association, has placed its stations and facilities at the disposal of railroads for use as a means of emergency communication should their regular wire system be interrupted. Actual use of this emergency service has been made several times during the past year.

INTERNATIONAL RADIOTELEPHONE SERVICE

Radiotelephone service between New York and London was made available to the public January 7, 1927. At present anyone in the United States and Cuba can talk with England, Scotland, and Wales. The radio transmitter on this side is at Rocky Point, Long Island, N. Y.; the receiving station at Houlton, Me. On the other side the transmitter is at Rugby, England, and the present receiving station is at Cupar, Scotland. When the service was established the receiver was at Wroughton, England. While the service is understood to be available 24 hours a day, its use is really limited to a shorter period because of the five hours difference in time.

Radiotelegraph is open to the public for communication from the United States to the following countries: England, France, Germany, Italv, Poland, Norway, Sweden, Holland, Argentina, Brazil, St. Martins, Japan, Philippines, Dutch East Indies, French Indo-China, Colombia, Panama, Costa Rica, Nicaragua, Honduras, and Guatemala. This service also includes Swan Island in the Caribbean Sea and Hawaii.

Short waves (below 75 meters) are proving serviceable for transoceanic communication. Such circuits are now in use to England, Germany, Argentina, Philippines, Dutch East Indies, French Indo-China, and Hawaii. Expansion of this service is contemplated.

Beam transmission is now successfully accomplished. Shortly two circuits using this system will be put into operation in this country.

INTERNATIONAL RADIOTELEGRAPH CONFERENCES

As early as 1903 the use of radiotelegraphy for marine purposes had raised questions of international interest and it became evident that some international rules of procedure were necessary. In view of this situation the German Government invited other governments concerned to a preliminary conference in Berlin in August, 1903, where a draft of proposals was agreed upon as a basis of a convention to be discussed at a subsequent conference. There were 27 countries including the United States, represented at this preliminary conference.

After several postponements, the second conference, which was the first official International Radiotelegraph Conference, was held in Berlin in October, 1906. The deliberations covered a period of one month. The representation at this conference was much the same as that which attended the preliminary conference and included the United States. The primary object of the 1906 convention was to facilitate ship and shore communication. The subjects covered can be classified briefly as follows:

(*a*) The acceptance and transmission of telegrams.

(*b*) The adoption of uniform rules of working.

(*c*) The collection of charges and settlement of accounts between the different countries.

(*d*) Arrangement for publication of information necessary for intercommunication.

(*e*) Rules to prevent interference and confusion in working.

(*f*) Provision for intercommunication, with certain exceptions.

This convention was ratified by the United States on April 22, 1912.

The second official International Radiotelegraph Conference was held in London in 1912. The first meeting was held on June 4. The deliberations covered a period of about one month. There were 43 countries represented, including the United States. As at the former conference, the deliberations were confined to questions relating to the marine service. At that time transoceanic communication by radiotelegraphy had not been developed, the radiotelephone was of crude design, expensive, and unreliable in operation, and its use entirely experimental. The amateurs had not entered the intrenational communication field, and point-to-point service was limited to short distances with low power and given wave lengths which did not interfere seriously with the marine service.

The London convention was ratified by the United States on February 5, 1913.

At the London conference the United States delegation was authorized to extend an invitation to hold the next conference in Washington in 1917. Subsequent events made several postponements necessary. Finally the date was set as October 4, 1927, 10 years later than originally contemplated. During this lapse of time many unforeseen problems have arisen and the development and use of radio has rendered the old treaty obsolete. A complete revision of the convention is necessary to meet the present operating conditions, taking into consideration modern apparatus, more efficient methods, and new services.

INTERNATIONAL RADIO ACCOUNTING

The London radiotelegraph convention of 1912, to which the United States is signatory, requires each administration to provide for the collection of tolls from vessels under its registry for radio service exchanged through stations of other administrations.

The following summary covers the principal operations of the accounting section of the radio division for the period from July 1, 1926, to June 30, 1927, in carrying out the terms of the convention:

Accounts received from and settled with other administrations and companies

Accounts on hand July 1, 1926	644
Accounts received during year	969
Total	1,613
Accounts settled and cleared	914
Accounts on hand and unsettled June 30, 1927	699

The financial operations were as follows:

Cash balance, July 1, 1926	$44,214.47
Collections from American companies	85,927.47
Total	130,141.94
Disbursements to foreign administrations and companies	62,259.53
Cash balance, June 30, 1927	67,882.41

The accounts mentioned above range in value from $1 to $2,000 each. The number of administrations and foreign companies acting independently of administrations and submitting accounts for collection during the year was 101; the individual accounts covered periods of from one to six months each. It is to be noted that the accounts are itemized message by message, all of which are required to be billed against the responsible ship or radio authorities. The accounting section of the radio division operates as an international clearing house for radio traffic accounts, collecting the amounts due from shipowners or private radio companies, and liquidating with the foreign administrations.

In addition to the foregoing, the radio division has assisted American radio companies in the collection of accounts due them from foreign administrations and companies covering the tolls for service rendered foreign ships by domestic coastal stations. Canada, Spain, Italy, Greece, and other administrations have availed themselves frequently of this method of settling their accounts with American companies.

ACKNOWLEDGMENT

I desire to bring to your attention the helpful cooperation which the radio division has received from the industries and to acknowledge my appreciation of their assistance, without which we could not have successfully functioned.

Very truly yours,

W. D. TERRELL,
Chief, Radio Division.

BUREAU OF THE CENSUS

DEPARTMENT OF COMMERCE,
BUREAU OF THE CENSUS,
Washington, July 1, 1927.

Hon. HERBERT HOOVER,
Secretary of Commerce.

DEAR MR. SECRETARY: I have the honor to submit the following report summarizing the activities of the Bureau of the Census during the fiscal year ended June 30, 1927:

INTRODUCTION AND SUMMARY

The increasing interest in statistics is due to the growing recognition of the fact that in government, in business, and in affairs of life, statistics are one of the most definite indications of the direction in which certain sociological, economic, and industrial currents are moving. A constantly increasing number of groups of facts bearing upon the daily life of a great nation are now statistically summarized and daily utilized in business. The large and complex group of statistical inquiries which it makes annually tax to the utmost the resources of the Bureau of the Census.

Every year the bureau compiles and publishes data relating to births, deaths, marriages, and divorces, giving numbers and more or less detailed tabulations not only for the United States as a whole but for individual States, cities, and counties. The net gain in the population of the United States is estimated upon the basis of the reported births, deaths, immigration, and emigration, and apportioned among the States; and up to the present year, as elsewhere explained in this report (p. 55), annual estimates of population have been made for cities and counties as well as States. In a number of instances actual enumerations or censuses have been taken by the bureau at the expense of the city concerned. Recently the bureau has begun the annual compilation of statistics of prisoners and of the inmates of hospitals for the mentally diseased. These social statistics have been accompanied by a mass of detailed data for agriculture, industry, and business. We compile a greater volume of statistical material and cover a greater variety of topics than any other country. The bureau in the last fiscal year published 3,571,138 items, each containing a number of figures representing some phase of our social, industrial, or business activity. In addition, many facts and figures were furnished in reply to 48,000 letters of inquiry, and many others supplied verbally or by telephone or telegraph. Civilization is now so complex, so sensitive in its manifestations and reactions, that statistics are essential. The demands for data that can be furnished by the census, and only by this bureau, have been constantly increasing.

The figures for individuals or business enterprises are assembled and presented in a manner to give the greatest amount of information. Reports were received from or concerning 5,259,813 individuals or enterprises. In addition, more or less tabulation was done on 11,029,956 reports, making a total of 16,289,769 reports handled during the year. The statistics were published in 2,701 mimeographed and printed statements and bulletins with a total edition of 5,419,298.

FIFTEENTH CENSUS

There are few kinds of statistics which do not depend for their complete development, and for some part of their significance, upon population—the people to whom those statistics relate or whose life or industry they portray. The population of the United States presents a very complex ethnological problem. The population is an admixture of races and nationalities more diverse than those found in any other country. The occupations of the people are practically all-inclusive, presenting unequaled advantages for the study of social and industrial conditions. The number, size, and variations in boundaries of political units for which the population must be shown far exceed those of any other nation. The enumeration of the population is, therefore, the biggest, and in many respects the most complicated piece of statistical work ever undertaken. At the time of establishing the permanent census office there was an understanding that the permanent force of the office would or could be employed on the preliminary work for the decennial census in advance of the census period; but other duties have made it difficult to give proper attention to the work that it is necessary to do before starting the decennial census.

There has been a constant pressure to postpone this preliminary work, and it is safe to say that at no decennial census have satisfactory preliminary arrangements been made for the elaborate organization. During the current and coming year it will be my effort to devote adequate time and attention to this important matter. The entire country must be subdivided into enumeration districts, accurately described, and mapped. Information regarding conditions in each district must be secured in order to ascertain, so far as possible, the changes that have taken place in population and in the boundaries of cities and townships or other political divisions since the census of 1920. It is necessary to take into account the sparsity or density of population, the physiographical features of the country, the character and condition of the roads, and other factors. The boundaries of the enumeration districts must be clearly defined and described in order that there may be no overlapping and no omitted territory. For this purpose it is necessary to secure or prepare reliable and up-to-date maps of every county and city. At the last census there were approximately 86,000 enumeration districts; at the coming census the number will doubtless be in excess of 100,000.

While the defining of the enumeration districts is perhaps the most urgent and important preparatory task which the bureau has in hand at this time, there are many other things which must be done to get ready for the next census. Legislation making provision for the census and embodying such changes in the existing law as experience and changed conditions have shown to be desirable must be drafted

and submitted to Congress. The schedules, instructions to enumerators, and other forms and supplies to be used in taking the census must be prepared, printed, and shipped to all parts of the United States well in advance of the date of the enumeration. It is necessary also to provide and have in readiness the necessary mechanical equipment for tabulating the data, to plan the scheme of tabulation, involving the successive "runs" of the cards, to determine what detail is to be tabulated and published, and outline the tables. These and other things must be done before it can be said that we are "ready" for the next census.

The census of 1930 will be the Fifteenth Decennial Census of the United States. The First Census, taken in 1790, enumerated a population of not quite four million (3,929,214). The last, or Fourteenth Census, taken in 1920, enumerated over one hundred and five million (105,710,620). The expectation is that by 1930, when the next census will be taken, the population of continental United States will have reached a total of about 124,000,000, which is more than thirty times the population enumerated at the First Census.

In 1902 the Bureau of the Census was established on a permanent basis, thus making it possible to divorce from the decennial census all those inquiries the data for which can be collected without a house-to-house canvass; and there are many inquiries of that class which are now being conducted by the bureau every tenth, fifth, or second year in the interval between the decennial censuses, as well as others which may be said to be continuous, the data being collected annually, quarterly, or monthly.

At the censuses of 1910 and 1920 the three main subjects covered were population, agriculture, and manufactures. Mortality statistics, which had been included in the census of 1900, were now covered by the annual compilation of deaths, inaugurated in 1902. Both censuses, 1910 and 1920, included a report on mines and quarries, and the census of 1920 included reports of drainage and irrigation.

Of the various subjects that have been covered by the decennial census, population is by far the most important and fundamental. Besides being necessary under the Constitution as a basis for the apportionment of Representatives in Congress, it yields information of the highest value and of fundamental importance in connection with business, legislation, sanitation, education, finance, government, and other human activities. It is the basis of all statistical inquiries that deal with social or economic phenomena. The compilation of data regarding births, deaths, and marriages, for instance, would be worthless if the results could not be related to the data obtained through the population census. Population figures are equally necessary for the understanding and interpretation of statistics of production, distribution, and transportation. In fact, the knowledge obtained by the census of population seems to be fundamental in almost every field of social or economic activity and in practically all branches of social or political science.

The population census is no longer the simple matter that it was originally. It calls for a mass of detail and for elaborate tabulations. It is necessary to tabulate and to publish data in more or less detail for each State, county, city, and incorporated village or borough having more than 2,500 inhabitants, and to show at least the

total population for every other incorporated place and every township, ward, or similar political subdivision.

ESTIMATES OF POPULATION

Estimates of population are needed as a basis for computing per capita rates, particularly birth rates and death rates, and are very much in demand for the use of State and county officials, trade organizations, and business concerns. But with each successive year following a census estimates become more uncertain and unsatisfactory, especially as regards the counties and smaller cities. Estimates of the total population of the United States are based on the records of births, deaths, and net immigration, so that the results can be accepted with a good degree of confidence, notwithstanding the lapse of time since the last census. But this is a method which is not applicable to the individual State or to smaller political units, since we have no record of the migration to or from States and cities. In estimating the population of the States the bureau makes the assumption that the total increase of population for the United States since 1920 has been distributed among the States in the same proportions as the total increase between 1910 and 1920. In estimating the population of individual cities and counties, however, no better practicable method has been discovered than that of projecting the increase shown by the last two censuses; and since that method, as applied seven years after a census yields very uncertain results, the bureau has decided to discontinue making estimates for counties and for cities of less than 30,000 population from now until the census of 1930 is taken. This procedure follows the precedent established in 1917, when similar action was taken by the bureau pending the census of 1920. The only remedy for this unsatisfactory situation appears to be a quinquennial census. Many cities recognize this, and 37 cities and 2 counties have financed an enumeration of the population since the census of 1920, the work being done under the supervision of a trained employee of the bureau. At the time of their enumeration these 39 cities and counties had a total population of 2,296,694, and the cost of their enumeration, excluding the value of the services of volunteer enumerators in 16 places, was approximately $82,500, or a per capita expenditure of $0.36.

CURRENT BUSINESS STATISTICS

During the year the bureau issued 2,106 reports, each containing distinct statistics concerning production, stocks, consumption, or prices of one or more commodities. These reports contain approximately 524,000 items presented in the manner that manufacturers, merchants, and others interested in such information considered most instructive and helpful. The bureau has uniformly refrained from the collection of statistics of this character unless the manufacturers, merchants, and others required to furnish the data considered the statistics of sufficient importance to justify the undertaking. The figures are now assembled from separate reports made by 271,692 concerns direct to the bureau and from consolidated reports representing 12,000 concerns, for which the data are assembled by 120 organizations, each representing a distinct industry.

Survey of Current Business.—The monthly publication issued by this bureau, entitled "Survey of Current Business," has come to have a definite place among publications on business statistics. This bulletin contains now more than 1,700 individual statistical series, covering most of the basic industrial and commercial movements.

There is evidence of an increasing activity and interest on the part of trade associations and individual manufacturers in matters purely statistical. During the year current statistics were made available for the first time through the cooperation of trade associations and individual manufacturers on domestic pumps and water systems, water softeners, steel boilers, enameled sheet-metal ware, and electrical goods. The collection of these data, almost without exception, has been undertaken at the request of a representative number of firms in the industry concerned and only after receipt of their promises to report the data promptly. While it is the general policy to publish data made available by trade associations, in those cases where there is no trade association, or none that is thoroughly representative of the industry, the bureau will collect current statistical data from individual manufacturers if a majority of them request it. From the results obtained along this line during the past year it is apparent that there has grown up a feeling of greater confidence on the part of industry in the work of the bureau in the collection of current industrial statistics.

More and more business men have come to realize the value of current statistics, such as appear in this publication, in the planning of forward-looking policies, covering the entire scope of business and industrial management, from purchases of raw materials to the establishment of sales quotas, from an analysis of commodity stocks to a determination of credits.

Out of this work there has grown up a greater appreciation of the services rendered by the Government to business. Requests for all types of information covering market analysis, establishment of sales quotas, commodity surveys, etc., have been increasingly large. While in many cases much of the desired information is not obtainable, the requests to the bureau clearly indicate the fuller realization on the part of business generally of the value of factual information.

Cotton.—The cotton industry in its various phases touches intimately a large proportion of the people of the United States. The staple is grown on approximately 2,000,000 farms and ginned in more than 15,000 ginneries located in 978 counties in 19 States. It furnishes the fiber for more than 37,000,000 spindles in the United States and for the greater portion of 126,000,000 spindles in foreign countries. It is the most valuable crop grown in the country except corn and from a commercial standpoint is even more important than corn, since the entire crop enters commercial channels. As a result of the widespread effect on the general welfare it is of the greatest importance that reliable, unprejudiced information concerning the cotton situation be available to the entire industry. Consequently, the current periodical cotton reports are probably more critically analyzed than are those of any other of our basic commodities. To meet the need for complete and impartial statistics Congress directed this bureau to collect the data from the individual ginneries, consuming establishments, and storages and provided

funds for the employment of 775 local special agents at an annual expenditure of about $275,000.

Monthly reports of cotton consumed and on hand, inaugurated with September, 1912, have been collected and published. The statistics cover all cotton consumed, regardless of the character of the industry. Reports of cotton spindles and active spindle hours, inaugurated with August, 1921, have been issued for each month. These statistics of active spindle hours furnish a better measure of activity in the industry than is possible by securing, as formerly, only the number of spindles which were operated at some time during the month without reference to the number of hours of operation.

There were collected and published monthly reports of cottonseed received, crushed, and on hand, and cottonseed products manufactured, shipped out, and on hand. These statistics, which have been issued for each month beginning with August, 1916, cover the returns of the crushers of cottonseed and the refiners and consumers of cottonseed oil and include the quantities in storage and in transit. There was some delay on the part of a comparatively few concerns in forwarding the data, and the reports, until recently, were issued from the 17th to the 19th of the succeeding month. The statistics are an important source of information regarding the situation in the industry and the associations and others have undertaken to speed up the mailing of the returns, with the result that the report for the month of February was issued on March 15 and the reports for March, April, and May on the 13th of the succeeding month.

Special care has been taken to verify the data returned by the several reporting units. At the end of the season each ginner is requested to furnish a report direct, thus making possible a check on the data collected by the special agents. Each cotton-consuming establishment is furnished a statement of the monthly reports submitted during the cotton year for verification. A similar practice is followed in verifying the reports on cotton in public storage and those from cottonseed-oil mills and from refineries and consuming establishments using cottonseed oil. This method permits the making of necessary changes in the statistics as published in the preliminary reports, such revisions being carried into the final figures which appear in the annual bulletins. The ginneries and other establishments cooperate fully with the bureau and the reports are now secured promptly from all sources.

Fats and oils.—Quarterly reports concerning the production, consumption, and stocks of the several animal fats and vegetable oils were collected during the year. These statistics cover some 60 commodities and relate to the quantities produced and consumed in factory operations and stocks held in the factories and in storages.

Tobacco.—The bureau collected and published statistics of the quantity of the several types of leaf tobacco held by registered dealers and certain classes of manufacturers at the beginning of each quarter. These quarterly reports have been assembled and printed in a bulletin which also presents statistics concerning the several phases of the industry compiled from the reports of other bureaus and organizations.

Hides, skins, and leather.—A series of seven preliminary reports is issued from 5 to 15 days in advance of the regular report on this subject each month. The preliminary statistics include the leading

classifications of raw stocks of hides and skins, finished-leather stocks, stocks in process, and production of leather, with comparative data for past month and corresponding month one year previous, if available.

Immediately after the issuance of the December report an annual summary on production of leather is published. The last issue, covering production in 1926, with comparisons for 1925 and 1924, was published in more practical form than in previous years and did not duplicate figures published in the respective monthly reports.

Leather gloves and mittens.—The monthly report on gloves and mittens cut during 1927 covered a somewhat larger number of establishments than in the previous year. The summary on production for the year 1926 was condensed and simplified.

Boots and shoes.—In addition to the regular monthly report on production of boots and shoes, by classes, a semiannual summary on production, by States, was issued for the purpose of showing the trend of manufacturing activity in the leading States in this industry.

Wheat and flour.—The percentage of the total United States output represented by wheat-flour mills reporting has increased somewhat, due to the fact that the cooperation of a number of fairly large mills was secured during the year. This increase has been brought about, notwithstanding the fact that more than 50 small mills were dropped because their output failed to reach a total of 5,000 barrels each for the year.

Hosiery, knit underwear, and pyroxylin-coated textiles.—There has been very little change in the general plan of reporting these industries. The hosiery-stock item has been enlarged to include hosiery, both finished and in the gray.

Malleable castings, steel barrels, and mechanical stokers.—In order that there might be a definite basis for reporting capacity by establishments manufacturing steel barrels and malleable castings, tentative definitions were submitted to the manufacturers, who approved them almost unanimously.

Clothing.—The number of establishments reporting monthly on men's and boys' clothing has increased from 657 to 837 during the fiscal year. This increase included some very large establishments. Several important clothing associations indorsed the work as being of great utility in their investigations and have begun to take practical steps toward securing the cooperation of members who are not now furnishing the data. Statistics for men's clothing have been shown by leading markets, thereby presenting a more satisfactory basis of comparison.

Other inquiries.—For the monthly statistics on automobile production, figures for Canada are now provided by the Dominion Bureau of Statistics. The inquiries on wood distillation and on refined methanol have been combined and simplified in accordance with the recommendations of the National Wood Chemical Association. New inquiries were started during the year on steel boilers, on domestic pumps and water systems, on water softeners, on galvanized and enameled sheet metal ware, and on bookings of electrical goods. The number of reporting manufacturers was materially increased during the year in the inquiries on boxboard, Babbitt metal, steel castings, fabricated steel plate, and fabricated structural steel. The

regular inquiries on locomotives, fire-extinguishing apparatus, enameled sanitary ware, electrical industrial trucks and tractors, mining and industrial locomotives, steel furniture, terra cotta, floor and wall tile, and vitreous china plumbing fixtures were continued.

CENSUS OF DISTRIBUTION

Acting on your order of December 14, 1926, arrangements were made to collect statistics concerning distribution to form a part of an efficient report on the business movement of the country. The importance of statistics on this subject was generally recognized. Chambers of commerce and other business organizations, as well as individual merchants, offered to cooperate. Many of them gave substantial financial assistance. The Bureau of Foreign and Domestic Commerce and the Chamber of Commerce of the United States detailed employees to have charge of certain branches of the work. A consulting committee composed of representative business men was appointed for conference and advice. On the advice of this committee and other interested parties questionnaires were agreed upon and the following cities selected as appropriate for the trial canvass: Baltimore, Md.; Atlanta, Ga.; Chicago, Ill.; Denver, Colo.; Fargo, N. Dak.; Kansas City, Kans.; Kansas City, Mo.; Providence, Central Falls, and Pawtucket, R. I.; San Francisco, Alameda, Berkeley, and Oakland, Calif.; Seattle, Wash.; Springfield, Ill.; and Syracuse, N. Y.

It was understood that the business organizations and merchants in all of these cities would cooperate and that the confidential census statistical reports would be made freely and promptly. This spirit of assistance was necessary to avoid the delay that would accompany the enforcement of the compulsory provisions of the census laws, and also to increase the accuracy of the reports. The canvass in all of the cities was virtually finished by June 30, and 97,081 reports had been received. A number of merchants, however, requested additional time to prepare their reports, and a few have thus far declined to furnish any data. It will probably require some months to finish the canvass. This is unfortunate, as it delays the publication of the statistics that are now in such great demand.

The census of distribution includes all wholesalers, retailers, commission merchants, manufacturers' agents and brokers, and other classes engaged in the distribution of commodities. Many of the concerns were not able to segregate their sales of different classes of commodities, but it was found possible to compile fairly satisfactory data for 70 principal classes. Drug stores, hardware stores, grocers, and others sell such a variety of commodities that it was impossible to obtain an accurate record of each. Many merchants, agents, mail-order houses, and others sell goods for delivery elsewhere than the cities in which they are located. These and many other technicalities are incident to the distribution of commodities as now developed. The statistics that are now being tabulated and that are made public as rapidly as the work in each city is finished show the number of different classes of stores, kinds of business, number and classes of persons engaged, salaries and wages paid, stocks of commodities on hand, net and gross annual sales. The information is being presented in a manner most instructive and helpful, not only to the merchants but to the producers and ultimate consumers.

CENSUS OF MANUFACTURES

The biennial census of manufactures as now developed includes reports from 187,390 establishments engaged in the fabrication of materials, 4,859 laundries in which steam or other power-driven machinery is used, and 2,406 establishments engaged in the dyeing and cleaning industry. The last census covered the calendar year 1925. While practically all manufacturers recognized the importance of the statistics, many of them delayed the preparation of the census reports, and some of the reports did not reach the office until late in 1926. The establishments in a number of important industries had a keen appreciation of the value of the statistics and made their reports promptly. The bureau was therefore enabled to begin the distribution of the information by industries early in 1926, and the census was brought to substantial completion by the close of the fiscal year 1927.

The local chambers of commerce, boards of trade, and similar organizations aid in the collection of the census data. In return for this aid the bureau, at the earliest dates possible, sends summaries to the local cooperating agencies, with permission to make such use of them as they may see fit. Later the complete city statistics are assembled, together with State statistics, and published in the form of a printed pamphlet, which is incorporated into the bound volume containing the final reports of the biennial census.

Some idea of the magnitude of the work on manufactures may be gained from the fact that the total number of statistical items included in the reports—counting each item for the current year, but disregarding items for preceding census years, presented for purposes of comparison—is approximately 250,000. In order to tabulate these items the data on the manufacturers' returns must be carefully scrutinized to discover possible errors or inconsistencies; the entries on the returns must be transferred to tabulation sheets and totaled; the results must then be carefully analyzed to detect inconsistencies which were not found on the review of the individual returns; and the totals on the tabulation sheets must be brought together in the form of statistical tables. The proper performance of all this work necessarily and inevitably consumes many months; but, as already stated, a considerable part of this time would be saved if all the manufacturers would make their returns promptly, completely, and correctly.

AGRICULTURE

The second deficiency appropriation bill, which failed to pass at the last session of Congress, carried an item of $100,000 to enable the bureau to complete the detailed tabulations desired by the Department of Agriculture from the reports for the census of agriculture of 1925. While the failure of the item has made it impossible to compile all of the detailed data desired, the bureau has published reports giving for each State and each county all of the principal data collected for this census. The Department of Agriculture, however, desired, for use in various branches of research work, additional data for every State and county. In order to meet this requirement partially I readjusted the tabulation, and have arranged to print additional bulletins for each State giving the number of farms reporting

each of the various crops and classes of livestock; classifications of acreage and value by size of farm, and cooperative sales and purchases, and farm population by tenure. The compilation of these statistics and their publication by States and counties has made it necessary to omit the publication of certain information heretofore published for the census of agriculture, but to which the Department of Agriculture attached less importance. This arrangement has permitted the assembling of a large part of the material required for special studies of various branches of agriculture, but additional tabulation is required so as to show classifications by tenure of pasture lands, value of buildings, expenditures for feed, fertilizer, labor, and lumber, kinds of road, distance to market, tractors and radio receiving sets on farms, acreage and production of specified crops, and specified classes of livestock; and classifications of taxes and of mortgage debt by size and value of farm.

WATER TRANSPORTATION

To avoid the duplication of work that would have resulted if the census of water transportation for 1926 had been taken through a direct canvass of the owners of the vessels, as in 1916, a radical change was made in the method of handling this census. Much of the information required is now collected by the Board of Engineers for Rivers and Harbors of the War Department, by the Shipping Board, and by the Bureau of Navigation of the Department of Commerce. Arrangements have been made with the Board of Engineers and the Shipping Board to furnish tables showing freight and passengers carried during the year 1926, which while not classified in the same detail as the freight and passenger statistics in the 1916 census report will, it is believed, meet the requirements of those interested in statistics of water transportation.

Most of the information needed with regard to the number, tonnage, and other characteristics of documented vessels operated during 1926 will be tabulated from data on record in the Bureau of Navigation, supplemented by additional information with regard to vessels idle during 1926, which is being secured by that bureau, with the assistance of clerks detailed from this office.

Since there is nowhere available information as to the number and tonnage of undocumented boats (mainly barges and canal boats), a direct inquiry, conducted principally by mail, is being made with regard to these boats.

A few of the items carried in the 1916 census of water transportation are being omitted under the present plan because they were not obtainable, except through a direct canvass, and did not seem to be of sufficient importance to justify the very great additional expense. These items include the value of the vessels, the gross income, the amount paid for wages and salaries, and the number of employees on land.

FINANCIAL STATISTICS OF STATE AND CITY GOVERNMENTS

State governments.—The financial report for the 48 States for the year ending December 31, 1926, was completed four months earlier than the report for any previous year, the preliminary statistics being made available for all States May 31, 1927. These preliminary sum-

maries for the individual States are issued as rapidly as the field work in each State is completed.

The National Association of State Auditors, Comptrollers, and Treasurers devotes a great deal of time at its annual convention to the financial statistics of States as prepared by the bureau. This association has appointed a committee to advise with the bureau concerning the scope of its financial statistics and the method of presentation.

Financial statistics of cities.—The cities included in this annual report are those having a population of 30,000 and over as shown by the population census of 1920, or as shown by a special population census taken since that date. There were 250 cities in this class in 1926, and press summaries giving preliminary statistics for the fiscal year 1926 had been issued for three-fourths of these cities by June 30, 1927. The copy for the final report on this subject will be ready to go to the printer as soon as the summary for the last city is issued.

The bureau has been collecting the statistics of cities annually since 1903, and certain summaries have been made for 146 cities which have been included in the report each year.

The National Association of Comptrollers and Accounting Officers, originally called together by the Director of the Census in 1903, and organized at that time, has for its object the improvement in methods of public finance and the extension of the movement for the installation of uniform systems of State and municipal accounting and reporting throughout the United States, together with the general development of the principles of economy and efficiency in National, State, and municipal administration and the promotion of legislation toward these ends. A committee of this association has been appointed to cooperate with the bureau in the compilation of its annual financial statistics of cities. This committee met in Washington May 19, 20, and 21, 1927, and discussed various subjects connected with the collection and presentation of financial statistics of cities, such as debt limitation or restrictions by cities based on assessed valuation of taxable property, the amount of general property taxes levied required for debt retirement and sinking-fund purposes, and the inclusion of cost by other civil divisions of certain activities to make the reports of cities more comparable with each other.

The most important work of the association at present is to urge upon city officials the necessity of having uniform classifications of accounts, and it devotes an entire day to the discussion of this subject at each of its annual conventions.

VITAL STATISTICS

There is no Federal law which governs the registration of births and deaths. Such registration is entirely under the control of each State. Since 1900 the bureau has been endeavoring to have the government of each State adopt and properly enforce a satisfactory registration law. In each State adopting such a law the registration of the births and deaths has been systematically tested by experts of the bureau, and when the registration amounted to 90 per cent of the births and deaths the State was admitted to what is known as the registration area, for which the bureau compiles and publishes the birth and death data.

Last year I mentioned the active campaign being conducted to bring every State into the registration area before 1930, so that national vital statistics might be obtained by that date. During the year the registration laws of Texas and Georgia have been improved, and Arizona and Arkansas have been added to the death-registration area, so that this area now comprises 42 States, 21 cities in other States, the District of Columbia, the Virgin Islands, and the Territory of Hawaii, the total population included being 108,635,000, or 91 per cent of the total for the United States.

In the past year four new States have been added to the birth-registration area—Arkansas, Arizona, Idaho, and Tennessee—so that this area now comprises 37 States, the District of Columbia, and the Virgin Islands, the population included being approximately 95,624,289, or 81 per cent of the total of the United States. Campaigns now under way to be launched within the next year cover Texas, Oklahoma, New Mexico, Colorado, Missouri, Georgia, and South Carolina, with every prospect of several of these States being added to the area within the next 12 months.

During 1925, the last year for which complete reports have been received in the bureau, there were 1,878,880 births in the birth registration area and 1,219,019 deaths in the death registration area. These figures show a mortality rate of 11.8 and a birth rate of 21.4 per 1,000 of the population.

In addition to the compilation of statistics and the publication of the regular annual reports on births, stillbirths, and deaths, the bureau has continued the publication of the weekly health index and of automobile fatalities.

Important constructive work has been done toward a revision of the standard death certificate and a revision of the International List of Causes of Death; and the revision of the Standard Nomenclature of Diseases and Pathological Conditions, Injuries, and Poisonings for the United States has steadily progressed.

During the year the bureau issued 108 mimeographed statements, with a total edition of 380,000, giving summary statistics concerning births, deaths, infant mortality, and automobile fatalities; it also printed two annual reports giving detailed statistics concerning births and deaths for the year 1924.

Automobile fatalities.—During the year the bureau has done considerable work for the committee on traffic accident statistics of the National Conference on Street and Highway Safety. Correspondence has been carried on with officials in different States and a general campaign inaugurated to encourage the collection of statistics concerning traffic accidents on uniform lines in different States and cities. The committee estimated that since 1906, when automobiles first assumed some importance in transportation, there have been in the United States 164,965 fatalities due to accidents in which automobiles were involved. Exact statistics on this subject are collected only from the States in the registration area, which for 1927 represents about 91.3 per cent of the total population.

The mortality rate from automobile fatalities has increased during the past five years from 11.5 to 17. This rapid increase in the number of deaths from automobile accidents has caused the bureau to extend its efforts toward securing more specific data relative thereto. During

1925 approximately 12,000 requests for information as to the locality where the fatal accident occurred were sent out and the information received in reply to these queries was used in compiling the annual summary of automobile fatalities for that year. Similar work is being carried on for 1926 and 1927.

A compilation of the number of deaths resulting from collisions of automobiles with railroad trains and with street cars was made for 1925 and will be continued for succeeding years.

Publication of the four-week summary of automobile fatalities, based on weekly telegraphic reports received from local registrars, is being continued. The latest of these summaries is that for the four weeks ended June 18, 1927, and shows data for 77 large cities, which in 1927 have a combined estimated population of 32,239,835.

The publication of reports on automobile fatalities serves to stimulate interest in the devising of methods for the prevention of accidents, as has already been shown in certain localities either by an actual reduction of the number of fatalities or by a diminishing rate of increase, and it is expected that the interest thus aroused will continue to increase and will lead to the adoption of measures which will result in the saving of many lives.

MARRIAGE AND DIVORCE

The statistics of marriage and divorce, which are now being collected annually, are received by the public with a high degree of interest, and we receive each year hundreds of press clippings commenting on the figures, especially on the declining marriage rate and the increasing divorce rate. There is possibly a tendency to exaggerate the extent of both of these movements—that is, to assume that the marriage rate is decreasing more rapidly than it really is and that the number of divorces is increasing more rapidly than the actual records show. It is especially important, therefore, that accurate official figures covering both marriages and divorces should be made available as promptly as possible.

This year for the first time statistics have been secured with regard to marriages annulled as well as divorces. The number of annulments reported for the year will be nearly 4,000, or somewhat less than 2 per cent of the number of divorces, taking the country as a whole.

The census reports on the subject of marriage now give only the number of marriages performed, without classification. It would doubtless be desirable to publish additional data, such as the age of the contracting parties, whether or not previously married, etc. As matters now stand, however, there is such a lack of uniformity in the information recorded by the officials issuing marriage licenses in the various States that it would be difficult to formulate any classification that could be obtained from the records in more than a small number of States.

The information with regard to divorces is obtained from court records which do contain fairly uniform information on a number of questions.

The statistics of marriages are now obtained from some office of the State government in 27 States, and the statistics for divorces are likewise obtained from State officials in 13 States, with at least one more State to be added to the list next year. In the other States the

information with regard to both marriages and divorces is obtained from county officials.

On June 30, 1927, the work of securing the information with regard to marriages and divorces in 1926 was about 90 per cent complete, reports having been received for 1,039,891 marriages and 169,281 divorces, as compared with a total of 1,182,005 marriages and 175,449 divorces for the year 1925, and preliminary press statements had been issued for 25 States.

RELIGIOUS BODIES

The census of religious bodies, as its name indicates, is a census of religious organizations rather than a census of the population classified according to denominational affiliation, such as is taken in Canada and a number of other countries. Because of the variations in the methods employed by the denominational organizations in compiling the statistics for their own yearbooks and other similar publications, and because of the fact that many of the denominations publish no statistics, it has been found necessary to base the census upon returns secured directly from the individual churches, congregations, and other local organizations. This has the further advantage of giving the census reports an independent foundation.

The principal task involved in this census is, therefore, to secure from each local unit of each of some 200 different religious denominations a report giving information with regard to its membership, property, expenditures, and activities. The whole number of local organizations from which schedules must be secured is about 225,000. On June 30 schedules had been secured from approximately 175,000 of this number, and a considerable number of additional schedules were known to be in the hands of special agents and others in the field having charge of the collection of the statistics for certain denominations.

After the list of churches with the correct addresses of the pastors has been obtained, a considerable amount of effort has been required to get a report for each church. The general plan has been to send a considerable number of requests, with reasonable intervals between. Each request has reduced the number of names remaining for the next following request, and approximately complete returns have been obtained from many denominations by the time the fifth request had been heard from. Telegrams have been sent to delinquent churches when the number was small, appeals have been made to denominational officials, and some schedules have been collected by representatives in the field.

About 30 denominations, for the most part small, but including some that it would be very difficult for the bureau to canvass directly, are being collected by men in the denominations, each appointed as a special agent to collect the returns complete for his denomination. The percentage of schedules received on June 30 from these denominations was very much smaller than for the denominations handled directly by this office, but many of the special agents have preferred to retain the schedules until the work was entirely completed, so that no partial returns were to be expected.

Complete returns had been received on June 30 for 71 denominations (most of them small denominations, however), and 42 other

denominations, including several of the more important ones, were between 90 and 99 per cent complete.

Statements with regard to denominational history, doctrine, etc., for inclusion in the reports of the census of religious bodies, are being prepared in each case by some person occupying a position of prominence or authority in the denomination concerned. As a matter of general policy, the tabulated results for each denomination are being submitted to the general organization of that denomination for approval before the figures are made public.

ANNUAL CENSUS OF INSTITUTIONS

During the past year the Census Bureau has inaugurated the annual census of institutions, which you authorized in response to the appeal of those interested in the development of more adequate statistics of criminals and of the mentally diseased and the mentally defective. This census has been limited, for the time being, to Federal and State penal institutions, hospitals for the insane, and institutions for the feeble-minded and epileptic.

The first step in organizing this inquiry was to announce the census plans to the State agencies in charge of institutions and to enlist their support of the project. In five States arrangements have been made to have the census reports furnished through the State agencies, and most of the other State agencies have cooperated very effectively toward making the census a success.

In connection with the annual census of prisons and reformatories, a manual of 64 pages, entitled "Instructions for Compiling Criminal Statistics," has been issued. In addition to instructions for making out the reports for the annual census of prisons and reformatories, the manual contains suggestions as to the statistics which should be compiled by jails and workhouses, police departments, courts, prosecutors, and parole and probation agencies, together with suggested table forms for such statistics. A standard record card for prisons and reformatories is also suggested. It is hoped that the manual may help to standardize and improve current State and local statistics of crime and criminals in the United States.

The distribution of schedules among the institutions was started in February. On June 30, 1927, complete or partial census reports had been received for 250, or about 74 per cent, of the 339 institutions which are included in the census, and most of the schedules received had been edited, ready for tabulation.

CENSUS RECORDS

The census schedules on file in the Bureau of the Census contain a vast amount of unpublished information which is invaluable to students of social conditions. They are of special value to historical societies and individuals studying small places for which no other records are in existence. During the past year 2,170 researchers consulted these records and secured data to serve for genealogical and other purposes. In addition, a corps of clerks are employed by the bureau searching the records for information requested by Members of Congress, Federal, State, and city officials, and individuals. The

census records are of special value at the present time in establishing the ages of Federal Government employees in connection with their retirement under the act of May 22, 1920. During the year 1,886,755 facts were furnished from these records.

State libraries, other organizations, and individuals interested in the preservation of material containing information concerning the early history of the United States have paid for photostat copies of the records.

At the census of 1890 a special form of schedule was used for the enumeration of the population. This schedule required a distinctive report for each family. Unfortunately, several years ago a fire in the building occupied by the Department of Commerce destroyed or damaged about three-fourths of these schedules. Many of the schedules can be placed in suitable condition for reference, but no appropriation has been made for their reconstruction and repair. Numerous requests are now received for information contained in these schedules, and as time elapses the demand for such information will be increased. I therefore renew the recommendation that authority be given for the repair of these schedules, and that a sufficient appropriation be made for this work. Unless such provision is made, the schedules will very shortly be in such shape that they can not be repaired. In the meantime they are being stored in a building that is not fireproof, and therefore are liable to further mutilation and possible destruction.

PRESERVATION OF CENSUS SCHEDULES

Six million four hundred thousand farm schedules were received for the census of agriculture, 1925. To make room for filing these schedules it was necessary to remove the schedules for the census of agriculture, 1920, to a warehouse pending arrangements for their destruction. Knowledge that these schedules had been removed and the possibility of their destruction provoked a number of letters from Senators and Representatives, State departments of agriculture, agricultural colleges, libraries, and other institutions interested in the preservation of records protesting against the destruction of these schedules for the census of agriculture. Similar protests have been received against the destruction of any schedules pertaining to our industries and population. Filing space for these numerous schedules must be provided or the schedules must be destroyed. It is impossible to preserve them in the Census Bureau building and at the same time provide space for the clerks and the necessary machinery that is required for the next census or for the annual work of the bureau.

TABULATING MACHINERY

Substantial progress was made during the year in perfecting the machinery and electrical devices necessary for the tabulation of the increasing detail data required for the different enumerations and for those that are to be undertaken in the immediate future. The equipment now consists of 2,283 machines of various character, such as sorting, tabulating, adding, mimeograph, multigraph, addressograph machines, typewriters, etc. Most of these machines were in active use

during all or part of the year. They were used not only to do the regular census work but to make tabulations to develop detailed statistics desired by various Federal and other Government offices, as well as for private interests. The following statement shows the number of cards punched and involved in the principal classes of work that were performed by the bureau during the year:

Bureau of the Census	93,301,997
Department of Agriculture	8,802,297
Bureau of Efficiency	569,207
General Supply Committee	886,977
Pension Bureau	226,316
New York State Census	22,789,040
Cities Census Committee (Inc.), New York	2,997,181
Plain Dealer Publishing Co., Cleveland, Ohio	1,800,312
University of Chicago	2,546,509

Special tabulations were made to meet the requirements of universities, teachers, industrial organizations, and others desiring statistics in more detail than those contained in the regular census reports, to facilitate the study of conditions existing in local areas. There were about 200 requests of this character received during the year.

The economy and satisfaction of having data required by different Federal bureaus tabulated in the Census Bureau is being recognized; and to facilitate the work I have recommended that the appropriation for the next fiscal year contain a provision enabling the extension of this work.

COOPERATION IN STATISTICAL WORK

To comply with the requirements of the laws governing the work of the bureau, and in order to collect and compile the statistics in a manner which would be of the greatest advantage to the persons interested, the policy has been developed of securing the voluntary services of statisticians, economists, and others on advisory committees. One committee is a general advisory committee for the work of the entire bureau. Others are appointed especially to consider and make recommendations concerning the financial statistics of States; the financial statistics of cities; cotton production, consumption, and stocks; generation and utilization of electricity and the manufacture of electrical apparatus and supplies; and the scope and methods to be followed in the census of distribution. In addition, the bureau consults manufacturers, merchants, economists, and statisticians concerning each branch of work, and great improvement has been made not only in the form of the questionnaires used by the bureau for collecting the statistics but also in the method of presenting the data.

OFFICE FORCE

Number of employees.—The office force at the close of June 30, 1927, comprised 721 officials, clerks, etc.; 16 experts and assistants in the mechanical laboratory; and 67 temporary employees engaged on the work of the censuses of distribution and of religious bodies. In addition, there were 34 employees serving at $1 per annum, whose regular compensation was paid by certain social, industrial, or other organizations, and 67 employees detailed from other departments.

These two classes of agents were engaged in searching the census schedules for the purpose of obtaining data which are not included in the bureau's published reports. The average number of persons employed in the office in Washington during the entire year (exclusive of the $1 and without-compensation employees) was 929, as compared with 1,091 for the preceding year.

Appointments.—The total number of appointments (including reappointments, promotions, etc.) made from July 1, 1926, to June 30, 1927, was 881.

Promotions.—During the fiscal year 447 promotions were made, the majority of the increases amounting to $60 per annum. The average salary of the permanent force on June 30, 1927, was $1,747, which is 6.8 per cent higher than the average salary ($1,628) on June 30, 1924, prior to classification.

Separations.—The total number of persons separated from the service from July 1, 1926, to June 30, 1927, was 353. Of this number 124 resigned, 10 were transferred to other bureaus or departments, 20 were retired with annuities on account of age or disability, 8 died, 118 held limited appointments which expired, and 73 were separated by the termination of their services without prejudice.

Details.—The bureau detailed to other services of the department during the past fiscal year 10 employees for periods ranging from 15 days to 12 months, these details representing a total cost in salaries of $12,054.13.

FIELD FORCE

The field force at the close of June 30, 1927, numbered 987, and comprised 19 consulting experts, 741 special agents employed throughout the Cotton Belt to collect data for cotton reports, showing the quantity of cotton ginned to specified dates, cotton consumed and stocks held, bale weights, etc.; and 227 special agents employed, respectively, on the censuses of distribution and of religious bodies, on vital statistics, and on statistics of cities.

In addition, there were 477 special agents at $1 per annum, employees of chambers of commerce and other industrial organizations, 967 enumerators appointed for special censuses which were paid for by the localities, and 91 employees of other departments or bureaus.

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, 1927.

HON. HERBERT HOOVER,
Secretary of Commerce.

DEAR MR. SECRETARY: I have the pleasure of transmitting the following condensed report upon the work of the bureau during the fiscal year ended June 30, 1927.

An increase of nearly 23 per cent over the preceding year in the total number of commercial services rendered has been the outstanding feature of the work—this being especially remarkable in view of the fact that the appropriations available for the bureau's use were only 10 per cent larger. In nearly two and one-half million cases our organization has responded to the expressed desire of American business men for pertinent information or direct assistance in the acquiring of new business or the furthering of already established trade. This may be regarded as a thoroughly healthy increase—indicative not only of a growing interest in foreign markets but also of a greater familiarity with the bureau's facilities.

Contributing to this result has been the expansion of the bureau's organization within the United States through the opening of six new district offices and five new cooperative offices in regions where the quickening of foreign-trade interest seemed particularly desirable. The response to this action has been most gratifying.

A significant evidence of the livelier interest in oversea markets, as stimulated by the bureau's activities, is the fact that during the past fiscal year the requests for reserved information on foreign-trade opportunities announced by the bureau numbered 141,284 *more* than in the preceding 12-month period—an increase of 32 per cent.

Another striking fact is that, among the hundreds of firms reporting dollars-and-cents benefits from the bureau's service, the average benefit per firm during the fiscal year just ended—about $24,000—was nearly three times the average amount reported for 1925–26; and when it is borne in mind that more than 20,000 firms use the bureau's facilities regularly it will be appreciated that the total returns, in money, from these trade-promotive efforts reached an extremely large amount. Clearly, the American taxpayer is collecting most substantial dividends on his investment in the services of this organization.

The event of greatest importance for the bureau occurring during the past year—an event that really marks an epoch in the history of our organization—was the passage by Congress and the approval

by the President of the Hoch Act establishing the Foreign Commerce Service on a secure basis in law. This law was sponsored by Representative Homer Hoch, of Kansas, and Senator Frank B. Willis, of Ohio.

For more than 21 years the Department of Commerce had actually maintained an investigatory and trade-promotive staff abroad. This service had grown steadily under congressional authorization but had never had a fixed or permanent legislative status.

The American business community, realizing the great practical value of these foreign representatives, had repeatedly urged the desirability of a legislative enactment that would give to the service a definite, enduring organization; clearly indicated salaries, functions, and prerogatives; and requisite legal authority for the persons charged with its direction. Earnest efforts were made for a number of years to obtain this highly necessary legislation.

These efforts were crowned with success when the Hoch bill—embodying all the essential features just mentioned—became a law on March 3, 1927. By this act the Foreign Commerce Service became the officially designated trade-promotive agency of the United States Government. The new law has already had a most salutary effect on the morale of the members of the oversea staff. They feel that, under the act, they are assured of a genuine career, a secure status, and continued equitable treatment in respect of all matters vital to their welfare and to the success of their endeavors.

During the past year the bureau has embarked upon a campaign of more vigorous and comprehensive effort in the field of domestic commerce—and it is planned, in the future, to devote much greater attention, and to allocate substantially larger sums, to this phase of the work. The bureau feels the duty of developing this domestic-trade service in a degree proportionate to its undoubted importance and to the insistent demand for it that has arisen in various lines of trade and in numerous localities throughout the country. Only in this way can a thoroughly well-balanced, rounded service be maintained.

In this field, as in others, the greatest care will be taken to avoid any action savoring of the "paternalistic." The bureau appreciates fully the value of private initiative and collective "self-help," and its purpose is not to proffer aid unless the service in view is obviously one that can be performed effectively only by a Government agency. Its attitude in this matter is rather one of *collaboration* with industry and with local bodies striving to improve conditions. This collaborative character of the work is accentuated by the cooperation existing between the bureau and 65 or 70 representative committees of industry. Thus there are ample safeguards to insure that the bureau's efforts to further the efficient conduct of trade in the United States will be confined within the proper sphere of official activity. That such restrained and carefully directed activity can be immensely helpful is proved by the results that the domestic commerce division has already attained. The reaction of the business community has been uniformly favorable thus far, and the bureau is therefore encouraged to proceed along a line that manifestly holds so much of promise. In recognition of this tendency, and to further its development, a new assistant director of the bureau has been assigned exclusively to the domestic-commerce work.

Among the especially important things accomplished during the fiscal year 1926–27 the following seem worthy of being stressed:

1. The concluding efforts in connection with the raw-materials survey—covering rubber, nitrates, potash, coffee, sisal, etc.—with the attainment of results distinctly satisfactory to American industries and to the consuming public.

2. The completion of the economic survey of the Great Lakes-to-ocean waterway projects—a study of the utmost importance to the future of large sections of the Nation.

3. The study of the Balance of International Payments of the United States—with special attention to the "invisible" items—a work that has evoked very wide discussion in the press and has been hailed by economists as the best of its kind for any country in the world.

4. The carrying out of the Florida Transportation Field Survey—determining the facts regarding Florida's business as related to transportation.

5. The publication of the Atlas of Wholesale Grocery Territories—characterized by competent persons as having an actual value to the trade of not less than $5,000,000.

6. The World Motor-Vehicle Census, a study of very great interest to one of our largest industries—in fact, the first effort of this sort ever undertaken on a large and detailed scale.

7. The development of a special trade-information service for the motion-picture industry, protecting and advancing its interests throughout the world.

8. The preparation of the Commerce Yearbook (called by President Coolidge "a remarkably comprehensive compilation of useful information")—and especially of the new volume 2, covering in detail the situation in foreign countries.

9. The increasingly effective and practical service to American investment bankers in connection with the negotiation of foreign loans.

10. The assistance afforded to the textile industry by the establishment throughout the world of "rayon" as a generic term not subject to local trade-mark.

11. The extensive investigation of taxes levied by European countries on American exporters.

12. The very successful meeting of 200 high executives of the chemical industry held at the bureau's Washington headquarters in December, 1926.

These and numerous other accomplishments mentioned in the succeeding pages of this report show that the past fiscal year has been the most successful in the history of the bureau.

GROWTH IN THE BUREAU'S DOMESTIC-COMMERCE FUNCTIONS

When it is realized that more than 90 per cent of American business is in the domestic field, the rapid growth in the bureau's services in behalf of waste elimination in domestic distribution is not so remarkable as it might otherwise appear. Prior to 1926 the Bureau of Foreign and Domestic Commerce was known throughout the country almost wholly as an organization acting for the promotion

of our foreign trade. During the fiscal year just ended there has been strong evidence that business interests throughout the United States have awakened to the importance of the bureau's activities as an agency for the promotion of better domestic business methods. It is expected that the next few years will witness a broad expansion of the bureau's endeavors in this field.

ATTACKING THE PROBLEMS OF WASTE IN DOMESTIC TRADE

It may fairly be estimated that, in the course of a year, the total domestic business operations of the United States amount to not less than $80,000,000,000, excluding all the numerous and great "duplications," which would probably double or treble this volume. Competent students of the situation are convinced that from 10 to 15 per cent of this vast sum represents avoidable waste—the result of ill-advised or ineffective methods. Such waste, which nearly equals in value our total foreign trade—exports plus imports—is clearly apparent in many aspects of business, such as:

1. Wastes in the physical handling of goods, caused by (*a*) lack of simplification of lines and unstandardized purchasing; (*b*) lack of understanding of the cost of physical distribution; (*c*) overproduction and deterioration before use; (*d*) lack of cooperation among distribution agencies; (*e*) such factors as inadequate transportation and terminals, inefficient loading and shipping, poor packing practice, and unnecessary haulage.
2. Wastes in selling and advertising, due to (*a*) destructive competition by people who are exhausting their capital by reason of their scant understanding of the fundamentals of the business in which they are engaged; (*b*) enormous expenditure of effort and money in advertising and sales-promotion effort without adequate information on which to base such promotion; (*c*) lack of uniformity of business practices in terms and documents, with resultant misunderstandings, frauds, and disputes; (*d*) lack of standards of quality and grades, and unnecessary multiplication of terms, sizes, and varieties; (*e*) bad credits; (*f*) the presence of too many links in the distribution chain and too many chains in the system; (*g*) unfair practices of small minorities; (*h*) disorderly marketing, particularly of perishables, with attendant gluts and famines.
3. Wastes in buying, such as those resulting from (*a*) inadequate "measures" of the obsolescence of machinery and knowledge of when to replace it; (*b*) inadequate inventory control; (*c*) lack of conscious effort to eliminate seasonal and cyclical fluctuations in business; (*d*) inadequate information as to national stocks, and as to production and consumption, with attendant risks and speculation.

If, as the above-cited estimates indicate, the annual waste in the domestic transactions of this country amounts to more than $8,000,000,000 there is an extraordinarily large "mark to shoot at" for any service body concerned primarily (as is this bureau's domestic-commerce organization) with the preventing and extirpating of wastes in distribution.

For the fiscal year 1927–28 the appropriation available to the bureau for domestic-commerce work is $199,160—or less than one forty-thousandth of the loss which the bureau's activity in this sphere is intended to avert. The disproportion here is striking. Plainly, the amount devoted to this purpose deserves to be very considerably enlarged if any appreciable headway is to be made in checking the flood of waste. There is almost no other field of governmental effort that is capable of bringing about such direct and tremendous savings to the American people as a whole. The entire export trade of the United States during the fiscal year just ended was a little under

$5,000,000,000—or $3,000,000,000 less than the minimum estimate of the *waste* in the domestic trade. For the promotion of this export trade Congress has very wisely raised the bureau's appropriations steadily until now they exceed $3,500,000—more than 17 times as much as for the manifestly bigger domestic-commerce task. This anomaly should be adjusted, especially in the interest of the consumers here at home, who stand to profit most from the elimination of waste in business. Against this waste the bureau is now moving determinedly.

The domestic commerce division strives to make commerce within the United States as economical and efficient as possible by furnishing to American business men commercial information based on the division's market surveys, on research in problems of wasteful practices in trade, and on analyses of distributive methods reported by trade organizations.

SURVEYS OF DEFINITE MARKETING REGIONS

The major effort of the domestic commerce division has been directed, since 1924, toward the preparation of scientific analyses of definite marketing regions of the country. It is the purpose of these surveys to place in the hands of each merchant buying or selling in a given region a compact tabulation of the fundamental trading conditions within the area, so that he may know just what the buying power of each community therein may be, its marketing methods, and all tangible and intangible factors affecting trading in the region in question. He thus has an invaluable chart upon which he can map out his operations with the minimum of waste effort and cost.

All the bureau's work of this character is carried out in close collaboration with local chambers of commerce and similar organizations. No duplication of effort exists here. It is the local interests themselves that view the bureau's contribution to these studies with the keenest appreciation, describing the resulting data as of the utmost value for their purposes. They realize that, without this governmental collaboration, such data would be inaccessible to them, except perhaps after the most arduous research, at a probably prohibitive cost.

During the past fiscal year the demands for the first survey of this character, published under the title "Commercial Survey of the Philadelphia Marketing Area," necessitated a third edition of this report, of which more than 6,000 copies have thus far been sold. The second survey to be undertaken was that for the southeastern States—North and South Carolina, Georgia, Alabama, Florida, and eastern Tennessee. This study is the result of months of field work under the division's staff, experienced in this type of activity; and great care has been exercised to bring out clearly the special characteristics of the Southeast that determine market possibilities in that region. The report of this survey is now in press and will appear some time this fall.

Field work on the New England survey has been completed during the last 12 months. Important contributions to the success of this survey have been made by the New England Council, by universities, and by numerous other business and research organizations in that territory. Special acknowledgment is made of the services of the

New England Council, which in this as in so many other ways is striving to advance the commercial and industrial interests of this section of the Nation. Here, as in all these surveys, the bureau has pursued its policy of collaborating fully with local bodies. As a basis for the commercial analysis of wholesale and retail distribution in New England, 168 towns and cities in the six States were visited by representatives of the domestic commerce division, and interviews were held with more than 1,000 wholesalers, retailers, manufacturers, sales managers, banks, chambers of commerce, and public officials. Approximately 20,000 miles were traveled in obtaining information relative to merchandising practices, trading territories, purchasing habits, and local characteristics of the trade. Inquiries were sent to all New England manufacturers, covering methods of plant operation and of distribution, advertising policies, and extent of sales for the year. Fifteen thousand questionnaires have been distributed to consumers in various sections of New England in order to ascertain their preferences and practices, including out-of-town buying, trade-marked goods, chain-store patronage, and mail-order purchases. A special study of warehousing facilities was undertaken at the request of the New England warehousemen. The results of this work have been classified and analyzed, and the report of the New England survey is now being written.

Four men are now engaged in preliminary field work on a market survey of the southwestern district, including California, Nevada, Arizona, and Utah. Another survey will be started in the upper Mississippi Valley soon after July 1. Urgent requests for similar studies are coming in from various parts of the country. As a result of the initiative and cooperative efforts of local officials in several regions, recommendations for additional regional market surveys will be included in the 1928–29 Budget.

In connection with the market survey of the New England district, considerable attention has been given to the movement of commodities in and out of that territory. In an effort to reach a definite balance of the commodity movement for the region, these data have been obtained in cooperation with the railroads and other carriers serving the territory. It is proposed to extend these studies in connection with other regional surveys in order to obtain a clear picture of commodity movements within definite sections of the country.

ATLAS OF WHOLESALE GROCERY TERRITORIES

The division's Atlas of Wholesale Grocery Territories was released March 28, 1927. Though the cost of publication necessitated placing the sales price at $1.25 per copy, the Government Printing Office reports distribution of more than 3,500 copies, as of July 1. The response which this publication aroused has opened up a whole series of problems, carrying the division into a wide range of work. The grocery marketing areas have been accepted by the trades as applicable to wholesale distribution of a variety of consumer commodities. The bureau has received urgent requests to make further studies in this field, with the object of defining major marketing areas which would be applicable to a large number of commodities and for which statistical material could be compiled. Requests have also been re-

ceived for studies on marketing areas used in the distribution of industrial goods such as raw materials, factory machinery, etc.

The great value of such a study as the Atlas of Wholesale Grocery Territories is conclusively shown by such letters as that from a very well-known packing company in New York State, whose sales manager writes: "I would estimate that to secure even an approximately accurate survey of primary and secondary trading areas would entail a cost of not less than $5,000 in salary and expense to the individual manufacturer; my personal estimate of the value of the atlas (based on cost) is therefore $5,000, multiplied by the number of national distributors who might conceivably use it." As there are more than 10,000 such firms in this line, it may be estimated most conservatively that one-tenth, or 1,000, can use the atlas to save similar expenditure. This would mean that a saving of $5,000,000 had been effected in behalf of better marketing in this one line through a single instance of the bureau's domestic-commerce work—a remarkable example of what it is possible to achieve in this field.

STUDY OF TRADE ASSOCIATION ACTIVITIES

During the year just closed the domestic commerce division has been in charge of the revision of the book known as Trade Association Activities. The new edition is now in the Printing Office. The purpose of this publication is to indicate the successful service of trade associations in the public interest. In the field of business research, in statistics, in simplification and standardization of commodities, in the promotion of arbitration in commercial disputes, in development of foreign trade, and in scores of other directions trade associations have made a most valued contribution to our economic progress. This book is a record of that continuing contribution.

The division prepares biennially a directory of trade associations. The 1926–27 edition, entitled "Commercial and Industrial Organizations of the United States," was released September 10, 1926. Sales of this new directory total 4,700 copies thus far.

MARKET-RESEARCH WORK

In October, 1926, the domestic commerce division was instrumental in calling a conference of men engaged in market-research work throughout the country. The purpose of this conference was to lessen duplication of effort through the organization of a central committee and various subcommittees, to direct the work of research agencies in productive channels. A number of subcommittees are now at work.

The first issue of a publication known as Market Research Agencies was released by this division November 8, 1926. This gives an annotated list of all market-research studies available from research agencies throughout the United States and serves as an aid in obviating duplication of effort. As of July 1, 3,900 copies have been sold. A new edition of this directory is now in preparation and will be available about November, 1927.

COSTS OF DISTRIBUTION—VARIED LINES OF EFFORT

One of the recommendations made by the domestic commerce division's advisory committee of prominent business men was for far-reaching studies into what may be called the fundamental costs of distribution—the relative volume of sales to costs, the cost of increasing territory, the costs of distributing individual lines of merchandise. Work undertaken along these lines during the latter part of the year promises to furnish valuable results.

Another new line of work undertaken by this division has to do with an attempt to simplify trade terms and trade practices. This is in an experimental stage at present. There is undoubtedly a need for work of this kind which, if it can be carried out, would result in the elimination of much wasteful effort and in the development of better business technique.

Another phase of this division's work has been the study of marketing problems for particular commodities. Funds have not been available to pursue this work to the extent which it demands. The commodity divisions of the bureau have in previous years cooperated with the domestic commerce division in the preparation of such commodity studies as have been made. The demand for Domestic Market Possibilities of Electrical Merchandising Lines necessitated the issuance of a new edition of this pamphlet in November, 1926. The foodstuffs division is at present cooperating in studies on canned foods and confectionery. Similar studies are under way or under consideration on a number of commodities, including toilet goods, knit underwear, machine tools, and sanitary ware.

Retail Store Problems, released in February, 1927, is a publication incorporating under one cover the series of bulletins on this general subject that were originally issued separately. Though previous editions of these separate studies totaling 160,000 copies have been exhausted, the sales of the reprint outnumber the distribution of all other domestic-commerce publications. Nineteen thousand copies of Retail Store Problems have been purchased since the release of this volume in February, 1927.

The domestic commerce division is cooperating with the Bureau of the Census and the Chamber of Commerce of the United States in the taking of an experimental "census of distribution" in 11 cities—Baltimore, Chicago, Fargo, Seattle, Denver, San Francisco, Kansas City, Springfield (Ill.), Providence, Syracuse, and Atlanta.

The receipt of many letters expressing astonishment at the degree of assistance which the bureau is able to give on domestic business problems, as well as regret that the bureau does not make its services of this character more widely known, has led to the placing of domestic-commerce representatives in some of the district offices. Such representatives have already been established in Kansas City and St. Louis. This plan will be extended to other offices as funds are made available. It is considered that in this way the services of the bureau in connection with domestic commerce can be brought to the attention of a large number of business men in the various districts.

AID FOR OTHER DEPARTMENTS—NOTABLE ECONOMIES EFFECTED

A significant phase of the bureau's work during the past year (as in previous years) has been that of effecting important economies for the United States Government through cooperation with other departments and the furnishing of expert advice and assistance to them on commercial matters.

The nature and value of such service is indicated in the following excerpts from a letter addressed by the Secretary of War to the Secretary of Commerce:

> I wish again to thank the Department of Commerce for the splendid help and cooperation given the War Department in our attempt to promote efficiency in current procurement by taking advantage of economic trends and conditions with a view of conserving Government funds.
>
> I feel that a continuation of the close cooperation of these two Government departments will result in a considerable saving in funds over a period of time.

The Secretary of War mentions "extremely helpful advice" from no fewer than six of the commodity divisions of this bureau, namely, those dealing with shoes and leather manufactures, textiles, coal, foodstuffs, lumber, and electrical equipment.

An example of the way in which this service operates may be taken from the work of our textile division. In cooperation with that division and with the Bureau of Standards, American silk manufacturers developed a new type of parachute-silk fabric which was built into parachutes and in official tests proved superior to the imported Japanese fabric generally used for this purpose. The Navy Department recently placed a contract for 326 parachutes made from the new American fabric and thereby saved more than $20,000. This award, which was the first to be made on open competitive bidding, established a precedent which should enable the Government to effect a substantial saving on every future purchase of parachutes.

At a suggestion from the textile division, the office of the chief coordinator consolidated an order for 120 parachutes for the Post Office Department with requirements of the Army Air Service, with a resultant saving of about $12,000. Initial efforts have been made to interest American cotton manufacturers in the weaving of balloon cloth from imported yarns. At present balloon cloth is imported from England. Government requirements of this cloth vary from year to year but would probably average about 200,000 yards annually.

The textile committee of the Federal Specifications Board, of which the chief of the bureau's textile division is chairman, completed during the past year an extensive survey of all existing Government specifications for textiles with a view to coordinating these requirements and devising master trade specifications, conforming to commercial practice and satisfactory to the individual departments, thereby permitting freer bidding and insuring more advantageous prices to the Government in its purchases. Approximately 1,600 items were considered and either eliminated, according to the rules of the Federal Specifications Board, or incorporated into master specifications, practically all of which had been promulgated at the end of the fiscal year.

The shoe division's advice to the War Department as to when to place contracts for Army footwear has resulted in noteworthy savings to the Government.

The hide and leather division has maintained close cooperation with other Government organizations, including the Quartermaster Corps (on leather procurement), the Bureau of Standards, and the Department of Agriculture.

For the Department of Agriculture, also, our division of regional information has prepared each month a survey of economic developments in the principal countries of Europe.

The service of economy, through the application of expert trade knowledge to the problem of conserving funds, is applied within the bureau itself as well as in relations with other departments. For example, the communications section of our transportation division devised an improved system for handling the bureau's own messages, resulting in annual savings of nearly $5,000 in the monthly cable reviews alone.

Thus, in manifold ways, the bureau organization is alert to save money for the Government and to promote harmony and coordination in the operation of the various branches of the public service.

THE FOREIGN-COMMERCE SERVICE

SUMMARY OF DOLLARS-AND-CENTS ACHIEVEMENTS

In the 42 foreign offices of the bureau that were in existence at the close of 1925–26, activities directly benefiting American industries continued to increase in volume and importance during the fiscal year just closed. The three *new* offices instituted during the year, at Cairo, Panama City, and Toronto, already have proved of such value in the promotion of this country's trade with the territories they cover as to afford ample justification for their establishment.

The passage of the Hoch Act, already discussed on page 71, has done much, during the last few months of the fiscal year, to strengthen the position and prestige of the Foreign Commerce Service and to insure its efficient functioning in the future.

It is, of course, impossible to calculate accurately the amount of business secured for American firms and of losses prevented in their behalf by the bureau's foreign offices. Nevertheless, an interesting indication of the dollars-and-cents value of these offices is afforded by this fact: A number of firms constituting only a small percentage of our regular clientele has voluntarily testified to a total of $16,089,254 as the value of business which they obtained or losses which they avoided through the activities of the foreign offices during the fiscal year just ended. This, it should be emphasized, is only a partial figure. It does not include the very large business growing out of trade programs, agencies, etc., established in previous years by the bureau's staff, the results of which are only gradually becoming evident. As compared with the above figure it may be noted that the total amount spent, directly or indirectly, for the maintenance and establishment of foreign offices during the year was less than $1,700,000.

The sum mentioned does not take into account several millions of dollars that have been indubitably saved or repaid to American firms

through the efforts of bureau representatives in bringing about a more favorable treatment of American merchandise, helping to adjust disputes between American firms and their foreign connections, forestalling tendencies that might have been highly damaging to established lines of this Nation's foreign-trade activity, or through many other concrete services of actual dollars-and-cents value.

SPECIFIC EXAMPLES OF SERVICE PRODUCING SUBSTANTIAL BUSINESS

The following examples of dollars-and-cents services to American business by the personnel of the bureau's foreign offices are representative, although no attempt is made to present anything like a complete picture of the work accomplished at any given station:

After the field representative of a Detroit automobile manufacturer had paid unsuccessful visits to Batavia, Dutch East Indies, over a period of two years, the American trade commissioner obtained for him a local dealer who is now buying cars to the value of $10,000 a month.

An important American cotton-goods house, with the advice and assistance of the bureau's trade commissioner at Batavia, did about $80,000 worth of business in five months in a market in which the introduction of American textiles is particularly difficult because the agencies for distribution usually have foreign affiliations and are averse to handling competitive American lines.

Thirty German firms, placed in contact with American manufacturers through the bureau's Berlin office, have notified the commercial attaché that the connections thus established have already resulted in new business worth $1,620,000.

A German importer was put in touch by the Berlin office with a manufacturer of artificial leather in the United States, and orders for this material totaling $5,500 were placed through this connection. A trade opportunity for the sale of automobile accessories and agricultural implements, originating with this office, netted orders totaling $12,000 for American manufacturers.

The Berlin office helped an American maker of lubricating systems to obtain an agent in Germany, and in three months orders were sent in totaling $300,000.

Two American firms manufacturing printing machinery secured orders amounting to $250,000 through German connections obtained for them by the Berlin office.

Road-making machinery valued at $8,500 was recently imported into Germany from the United States through efforts of the bureau's office in establishing connections between buyer and seller.

Through a connection established by the Buenos Aires office, a San Francisco fruit-exporting firm was able to do $100,000 worth of business with Argentina in a three-month period. With the help of this office, a sale of $32,000 worth of cyanide was made by an American company to the Argentine Government. The office also contributed to the defeat of a campaign against the use of this chemical—by the prompt and discriminating distribution of published material of the Department of Agriculture on this subject.

A hosiery-exporting house of New York was assisted by the Buenos Aires office in establishing an agency which has, thus far, brought about the sale of $5,000 worth of goods.

The bureau's new office at Cairo was opened February 1. Just at this time a difficulty arose that necessitated active cooperation of the commercial attaché with the American minister to prevent highly discriminatory local practices from destroying the trade of a Detroit motor-car company with an investment in Egypt of more than $1,000,000. As a result of the representations made by the United States officials in Cairo, the danger was averted.

The Cairo office has helped to establish several American automobile agencies in Egypt, and actual business recorded up to the end of the fiscal year, as a result of such connections, had totaled $42,000.

The Bombay office initiated negotiations that enabled an American piece-goods manufacturer to obtain an agent who placed an initial order for $25,000 worth of merchandise.

A former agent of a New York chemical firm in Calcutta had sold only $75 worth of its products in two years. The trade commissioner placed this concern in contact with a new agent, whose sales in five months amounted to $10,000.

An agency for American cigarettes, placed through the efforts of the bureau's Calcutta office, netted $25,000 worth of business in the first 10 months of its existence. For an American manufacturer of automobile spare parts the Bombay office secured an agent who placed quick orders to the value of $22,000.

American rubber footwear was sold in Denmark as a result of assistance from the Copenhagen office in securing a good agent. Another agency, arranged for a tire manufacturer at Akron, Ohio, resulted in orders amounting to $10,000 in 10 months.

Through the initial efforts of the bureau's Habana office an order was placed for a herd of American cattle to go to a stock farm in Cuba; these cattle were valued at $4,500. Along the same line a Michigan manufacturer of cattle feed was assisted in obtaining orders for his preparations amounting to $2,200.

The bureau's office at The Hague established connections in the Netherlands for several manufacturers of American automotive accessories, and thus far orders to the extent of $16,000 have been placed.

Hosiery manufacturers in the United States filled orders amounting to $21,000 for an agency in Hamburg, which was inaugurated through the efforts and advice of our office at that port.

An agent for Finland, obtained for an American automobile company by the bureau's Helsingfors office, did $147,000 worth of business during the year, while similar assistance to other motor-car manufacturers contributed to their attaining almost as impressive sales totals.

The Helsingfors office assisted in establishing a line of American outboard motors with a Finnish importer who bought these engines to the value of $6,000 during the year under review. Also efforts of this office resulted in sales in Finland for the same period of $25,000 worth of jute bags and burlaps.

The business of two American houses in South Africa, with a turnover of approximately $1,500,000, was in danger of material diminution. Through the intervention of the Johannesburg office, a reorganization was effected and new agents were appointed.

A connection established by the bureau's Lima office between a New York printing-machinery company and an agent in Peru has already

resulted in $50,000 worth of business. An agency arranged by the same office for a California milk-products concern has a proved yearly volume of $50,000. Efforts of the commercial attaché at this post in obtaining postponement of the application of a regulation affecting pure lard saved the producers and importers of American lard about $40,000. Peruvian hardware distributors bought $5,000 worth of American builders' hardware through the efforts of our office in establishing an active agency.

A British agency, obtained by the bureau's London office for an Ohio manufacturer of car-washing plants, resulted in business, from October to June, of nearly $20,000; through similar services by this office, a New York textile import house has done business amounting to $41,000; a yarn manufacturer, nearly $40,000; a California manufacturer of well-drilling machinery, $50,000 (initial order); and a Massachusetts specialty manufacturer, $50,000. A London firm, as a result of the services of the bureau's representatives in placing it in touch with American manufacturers, has sold $170,000 worth of automobile and radio equipment.

Through distribution of a trade opportunity cabled by the London office, the bureau's hide and leather division has enabled an American firm to get a contract for $110,000 worth of leather, $20,000 worth of which has already been shipped.

The efforts of the Madrid office relieved the Spanish subsidiary of an American oil company of the necessity of posting an unnecessarily excessive cash guaranty of about $1,500,000 (in a matter under discussion with the Government) that would have tied up the entire capital of the subsidiary company. This office also aided directly in obtaining for an American firm an order for electric cars amounting to more than $1,000,000. It successfully combated the proposed cancellation of Spanish contracts with an American shoe-machinery concern, which would have resulted in the loss of machines worth several hundred thousand dollars and would have ruined the company's business in Spain. Through the efforts of the Madrid office, paper machinery was sold for an Ohio firm to a Spanish paper mill to the value of $3,000.

The bureau's Manila office was instrumental in securing, for an American brass-manufacturing company, a connection that resulted in business to the extent of $10,577 during the year under review. A Manila cement factory bought American equipment valued at $6,500 on the recommendation of the same office.

Specifications furnished to the Electricity Commission at Melbourne, Australia, through the bureau's trade commissioner, resulted in orders to firms in the United States totaling $39,614. This office also was directly instrumental in bringing about the purchase of American materials valued at $250,000 for the construction of a new hotel. The same trade commissioner succeeded in placing an agency for an American concern selling traction engines, and orders for $56,630 resulted.

An Iowa packing firm was placed in touch with a representative in Mexico City, through the bureau's office there, and, as a result, sold $275,000 worth of lard in nine months. American canning machinery valued at $75,000 was sold to a Mexican Government educational agency through the efforts of the commercial attaché.

With the assistance of the commercial attaché at Montevideo, an American motor-truck company placed an agency in Uruguay which forwarded an initial order worth $25,000. The Montevideo office was also instrumental in effecting the sale of $10,000 worth of lumber by a New Orleans company to Uruguayan buyers.

The bureau's representative at Montreal secured a connection for Pennsylvania, Illinois, and New Jersey wall-paper manufacturers that brought orders amounting to $5,000. A New York novelty company has informed the Montreal office that its assistance has made it possible to anticipate new business amounting to $300,000.

Through reciprocal action suggested by the Ottawa office, American fire bricks were exempted from Canadian marking requirements, thereby saving exporters of this country about $750,000. A group-buying organization of 22 Canadian stores enlisted the services of this office in making connections in the United States, and the actual business resulting within 30 days was $100,000, with additional orders of several hundred thousand dollars expected to follow. The Ottawa office was also active in connecting a local department store with American manufacturers, who supplied the store with $74,000 worth of miscellaneous merchandise, consisting of dry goods, celluloid novelties, soda-fountain accessories, toilet articles, and stationery.

The French market was supplied with $7,917 worth of American bathing suits through an agency arrangement advised by the office of the commercial attaché at Paris.

Piece goods exported to the Philippines by a Boston concern and sold through an agent recommended by the American trade commissioner accounted for business of more than $104,000.

Paralysis of the American motion-picture business in Czechoslovakia, representing an annual return of $600,000 to the producers, was averted by prompt action on the part of the commercial attaché in obtaining postponement of a proposed import contingent which was to have been promulgated immediately.

Brazilian importers bought $47,469 worth of automobiles from three American manufacturers during the period under review, the agencies having been established through the efforts of the bureau's Rio de Janeiro office.

An Italian agency arranged for a Michigan motor-car company by the Rome office has resulted, despite an unfavorable business situation, in the sale during the year of at least $300,000 worth of automobiles. Orders for American builders' supplies to the value of $8,000 were placed by Italians through the efforts of this office.

An American airplane export corporation was assisted by the Santiago office in negotiations with the Chilean Government resulting in a $200,000 order. This office was successful in establishing satisfactory agencies for two American automobile manufacturers, and these agencies booked $128,000 worth of business during the year under review.

Through the Stockholm office there was obtained for a Texas firm a raw-cotton agency worth at least $100,000 a year in Swedish sales.

One of the largest distributors of automobile tires in Austria, who had been handling exclusively a well-known European make, became dissatisfied with his principal and was induced by the American

commercial attaché at Vienna to become the agent for a United States concern, under a contract calling for the sale of not less than $200,000 worth of tires a year; during the first six months of the arrangement sales of the American tires amounted to $130,000.

VARIED PHASES OF TRADE-PROMOTIVE ACTIVITY ABROAD

Field officers of the Bureau of Foreign and Domestic Commerce at the close of the fiscal year were located in 37 different countries, their roster comprising 29 commercial attachés, 50 trade commissioners, 48 assistant trade commissioners, and 16 American clerks. The productive efforts of this corps have made themselves felt in literally every branch of the foreign commerce of the United States, affecting every section of the Nation.

The difficulty of assigning a definite pecuniary value to many of the most important services of the foreign staff is obvious, but some idea may be given of the wide variety of their duties in specific instances.

Only passing mention need be made of the routine work of the Foreign Commerce Service, important as it is. The services of the field officers in preparing reports and attending to the needs of American commercial houses through correspondence and personal contact are well known to all who are in any way concerned with foreign trade. It is interesting to note the increasing importance of the offices as first points of contact for American business men traveling abroad. In all of the bureau's offices the volume of callers has increased throughout the year, including not only travelers from this country but also increasing numbers of native business men desirous of forming connections with American manufacturing concerns. At the Berlin office, for instance, 3,348 visitors were received during the past fiscal year, an increase of 38 per cent over 1925–26. At Montevideo, one of the smaller offices, the number of callers was 449, as compared with 290 the preceding year. These instances are typical.

OBTAINING SATISFACTORY FOREIGN CONNECTIONS FOR AMERICAN PRODUCERS: RESULTS BY STATES

Direct aid to the manufacturers and exporters of products of the United States in making satisfactory connections for the marketing of their goods abroad is one of the most highly appreciated functions of the bureau's field representatives. The wide geographic and commercial diversity of the American products whose sale has been promoted in this manner during the last year is especially striking. The instances given below comprise only cases where agencies were obtained or initial sales made through the efforts of members of the Foreign Commerce Service.

California's fruits and fruit juices have been sold in Java, Germany, India, Peru, France, and Sweden. Culverts, chemicals, and rubber goods from this State have gone to Finland; oil-well drilling equipment to England; and automotive accessories to Uruguay.

Drilling machinery from Colorado has been marketed in Spain.

From Connecticut automobiles and brake bands have gone to Germany; builders' hardware to Peru; brass rods, sheets, and pipes to Manila; and bearings to Sweden.

Through the bureau's foreign service, Delaware-made artificial leather has been sold in Germany; machinery from that State in Denmark; and explosives, dyes, and chemicals in Austria.

Sales of Florida cement have been made in Denmark. From Georgia hosiery has gone to British India and soft drinks to Austria.

Buyers for a diversity of the products of Illinois have been found by the bureau in Greece, Germany, Argentina, India, Denmark, Finland, Peru, England, Australia, Mexico, Uruguay, France, Italy, Chile, Sweden, and Austria. The goods thus exported included, in part, toilet preparations, soda-fountain equipment, plows, pea-canning machinery, household equipment, radio sets, automobile accessories, chewing gum, furniture, dental supplies, meat products, cartridges, automobiles, tractors, and several varieties of machinery.

Indiana, through the endeavors of the bureau's office at Athens, contributed the first electric vulcanizer used in Greece. It exported bicycle chains to the same nation and motor cars to Belgium, Egypt, Denmark, Finland, Peru, Spain, Chile, and Austria. Flour from this State went to Sweden, agricultural machinery and automobile accessories to Germany, tube well strainers to Calcutta, furnace cement to London, and chains and pumps to Austria.

From Iowa the exportation of patented lettering instruments to Greece has been aided by the bureau, of gland products and serums to Germany, fountain pens to India, power-plant specialties to Denmark, lard to Mexico, and serum to Czechoslovakia.

Sulphur from Louisiana has been marketed in Germany, paper from this State was sold in Mexico, and lumber in Uruguay.

The bureau's offices have helped producers of the State of Maine to export stepladders to Germany and toothpicks to Argentina.

Massachusetts merchandise marketed abroad during the past year through the efforts of the Foreign Commerce Service included winding machines, tools, leather, and motor cycles in Germany; tires, water coolers, and footwear in India; artificial leather and footwear in Denmark; fiber products, pneumatic scales, and yarn in England; textiles in Mexico and the Philippines; fiber products in Czechoslovakia; and tires, motor cycles, leather, and rubber goods in Austria.

The sale of automobiles and accessories, electric refrigerators, marine motors, and other products of Michigan has been promoted in Java, Germany, Egypt, India, Denmark, Finland, South Africa, Spain, the Philippines, Italy, Chile, Sweden, and Austria.

From Minnesota dental supplies have gone to Greece, gland products and serums to Germany, and marine engines to India.

Missouri exporters, with the bureau's help, have sold automobile valves and engines in Germany, automotive accessories in Argentina, inks and brushes in Denmark, automobiles in Finland, and motor trucks in Sweden.

Sales of Nebraska wagons were effected in Germany.

From New Jersey, through the intermediation of the foreign offices, machinery went to Germany, leather and automotive equipment to Belgium, pens and insecticides to Denmark, calculating machines to

Peru, imitation leather to the Philippines, petroleum products to Uruguay, leather to Sweden, and artificial leather to Vienna.

New York's foreign sales, effected through assistance of the Foreign Commerce Service, included radium products to Greece; drugs to Java; to Germany, roofing paint, sandpaper, saws, metal shears, rubber products, gland products, proprietary medicines, radio equipment, electric washing machines, chemicals, cellulose products, fireproof cement, automobile parts, pliers, toilet articles, electrical equipment, lubricating systems, abrasives, chewing gum, automobiles, canning machinery, graphite, manicure specialties, and aircraft instruments; to Belgium, aircraft instruments; to Argentina, hosiery; to Egypt, oil; to India, cigarettes, chemicals, cotton goods, linoleum, lace goods; to Denmark, bathing suits, electric hair clippers, wood oil, dried, fresh, and canned fruits, hosiery, motor trucks, machine oil; to Finland, jute bags, zinc plates, cosmetics; to Peru, printing machinery, firearms, drugs, books, machine tools, phonographs, automobiles, and tobacco; to England, rotary pumps, automobiles, textiles; to Manila, textiles, imitation jewelry, electrical automotive equipment; to Mexico, textiles; to Uruguay, machinery; to Czechoslovakia, airplane instruments, automobile accessories, radio apparatus; to Italy, paint and roofing specialties; to Chile, airplanes, petroleum products, paints, and varnishes; to Sweden, machine oil, parachutes, automobile accessories, foodstuffs; and to Austria, toilet articles, shoes, oils, radio equipment, cement, and paints.

Yarn from a North Carolina mill was sold in Argentina.

Ohio sent to Athens (through the assistance of this bureau's foreign representatives) pumps and automobile engine valves; to Java, honey, automobile wheels, and oilcloth; to Germany, printing machinery, toy balloons, machine tools, automobiles, tires, tractors, taximeters, electrical screw drivers, spark plugs, woodworking machinery, motor cycles, and hotel equipment; to Belgium, waterproof fabric; to Egypt, automobiles and tennis rackets; to Denmark, automobiles, tires, and roofing materials; to Finland, walnut wood, toy balloons, and motor trucks; to Peru, steam shovels, safes, locks, and rubber heels; to England, electrical cookers, toy balloons, car-washing plants, and hospital supplies; to Spain, suction rolls and rubber; to the Philippines, office furniture; to Chile, bank vaults and equipment; to Vienna, automobiles, tires, and rubber goods.

The bureau helped Oregon producers to sell bathing suits in India, lumber in England, fruit extracts in the Philippines, and apples and meat products in France.

Pennsylvania was aided in the sale of abrasive wheels, glass-making machinery, sandpaper, lawn mowers, gum balls, fiber, and celloron in Germany; pumps in Argentina; plumbing supplies in India; phonograph-record cleaners in Finland; road-making machinery and oil in Spain; air-compressing machinery in Uruguay; radio equipment in Rome; electric furnaces, batteries, and hair curlers in Sweden; and paints and fibers in Austria.

Tennessee tobacco was sold in Germany and candy machinery from this State in England.

Texas products marketed with the aid of bureau representatives included the first American ground sulphur ever sold in Greece, sulphur in Argentina, petroleum products in India, and cotton in Sweden.

Virginia, through the bureau's efforts, contributed tissue paper to Argentina, plaster to India, artificial leather to Finland, apples to England, and tobacco to Austria.

From the State of Washington candy was sold in Java; paper-making machinery in Germany; lumber, fruit, and canned goods in England; knit goods in Italy; and fruit in Stockholm.

Wisconsin products for which the Foreign Commerce Service helped to find foreign buyers included, in Germany, electrical switches, motor cycles, and road-building machinery; in Denmark, motors for boats; in Peru, steam shovels and aluminum goods; in London, molding machinery; in the Philippines, tractor crawlers; in Mexico, drive anchors; in Uruguay, leather; in Sweden, hosiery and wrenches; and in Vienna, excavating machinery and woodworking machinery.

AID IN CONNECTION WITH LARGE CONTRACTS, GOVERNMENTAL LOANS, ETC.

American interests were materally aided by the bureau's Johannesburg office in obtaining valuable options on Transvaal manganese deposits and in the acquisition of Rhodesian vanadium holdings.

Assistance was given by the Melbourne office to a New York banking organization that succeeded in arranging a £5,000,000 loan to the New South Wales Government.

The commercial attaché at Montevideo aided a number of representatives of United States financial houses, banks, and contracting companies who visited Uruguay to negotiate loans, obtain deposits of Uruguayan public funds in American institutions, and bid on public-works projects.

Foreign loans concluded in Italy during the year totaled $150,000,000—for the most part with the United States. The commercial attaché at Rome was consulted regarding different phases of many of these loans and was able to give advice which was of considerable value to the American interests involved.

The commercial attaché at Santiago was called upon for advice and assistance by representatives of American banking houses, one of which obtained two Chilean Government loans, totaling $70,000,000.

ADJUSTMENT OF TRADE DISPUTES AND DIFFICULTIES

In virtually all of the bureau's foreign offices an important feature of the year's work has been the adjustment of potentially costly disputes and misunderstandings between American principals, on the one hand, and, on the other, foreign agents or clients. This phase of the bureau's efforts does not encroach upon nor conflict with the work of private persons or organizations whose activities are directed to a like end. The bureau's offices are *not* collection agencies. They do not replace lawyers, banks, mercantile agencies, arbitration committees, chambers of commerce, or similar media for the untangling of individual commercial difficulties. The bureau's facilities for furthering such adjustments are brought into play only after all other means have been resorted to without success. In cases of that kind the Foreign Commerce Service has proved singularly apt in aiding the process of conciliation, harmonizing previously discordant viewpoints, and securing a just solution of the questions at issue.

The Berlin distributors for a Cleveland manufacturing company, who had refused to honor the latter's draft, were induced to do so through mediation by the bureau's office in the German capital. So satisfactorily was the matter adjusted that further sales have been made by the Ohio concern through the same distributors.

The Bucharest office brought about the payment of a number of drafts drawn by an American automobile company upon its Rumanian representative. In one instance the commercial attaché went so far as to obtain from the proper authorities necessary permission for the agent to purchase the foreign exchange needed to cover a draft for several thousand dollars.

The Buenos Aires office facilitated the obtaining of $6,000 due to a Rochester publishing company.

A Cairo firm being in liquidation and threatened with bankruptcy proceedings by local creditors, the bureau's office took possession of goods shipped to the concern by two American companies and was instrumental in finding new and more satisfactory agents for the latter.

The London office handled lumber claims for companies in Alabama, Washington, Tennessee, Louisiana, Virginia, Oregon, and Georgia.

The commercial attaché at Montevideo assisted in the adjustment of six trade disputes involving American firms.

Through the intervention of the Paris office, damages totaling $7,000 were paid to American firms by French concerns that had shipped them paraffin instead of beeswax.

The commercial attaché at Rome discovered that a Pennsylvania concern had accepted from its Italian representatives a series of drafts totaling about $35,000 which were null and void so far as their Italian legal status was concerned. Failure of the Italian agent to comply with certain requirements, which caused this situation, was immediately brought to the attention of the American company, which was thereby enabled to take steps necessary to avoid the possibility of a loss.

A dispute that threatened to terminate the connection of a Chicago radio-instrument manufacturing company and its Swedish agent was amicably adjusted by the Stockholm office. Since then the agent has been selling the American concern's products at the rate of more than $10,000 a year.

PROTECTION OF AMERICAN TRADE-MARKS AND COPYRIGHTS

The bureau's field representatives have continued their vigilance in behalf of American trade-marks and copyrights abroad, always in collaboration with the appropriate legal and other representatives of the interested firms.

One of the largest American soft-drink manufacturers was saved from heavy losses through the prompt action of the Berlin office in averting the pirating of its trade-mark and subsequently assisting it to enter the German market. This office also protected an American motor-car company from threatened loss consequent upon the operations of a swindler operating a make-believe company with alleged patents; the automobile company then was aided in obtaining an agent of its own and has begun a profitable German business.

Prompt cable notifications by the Buenos Aires office of attempted registrations by unauthorized parties saved trade-marks in Argentina for at least five American concerns.

The Manila office obtained Philippine registration for the trade-mark of a San Francisco firm after it had been refused on a technicality.

OBTAINING EQUITABLE TREATMENT FOR AMERICAN GOODS UNDER FOREIGN REGULATIVE MEASURES

Upon application of the commercial attaché at Berlin, the German Finance Ministry allowed a United States camera-manufacturing company a drawback of import duty on 300,000 meters of film every six months. This brought increased sales valued at $28,000 for the first year, and it was expected that the quota would be increased later.

When the South African "companies tax" was revised, the bureau's Johannesburg office was instrumental in having all American concerns operating in that country establish subsidiary companies, in accordance with the practice of our competitors in that market, so as to obviate the necessity of paying assessments against the entire capitalization of their parent concerns. Prompt action by the trade commissioner in this respect is estimated to have saved American interests upward of $425,000.

Efforts of the London office placed several United States concerns on a list of approved manufacturers for supplying railway material to the Egyptian State Railways.

As a result of meetings held in the office of the commercial attaché in London during August, the British market has been opened to American producers of collodion cotton.

Restrictions on foreign-exchange transactions were applied in Italy in such a way as to prohibit the transfers of receipts by subsidiaries of American motion-picture concerns to the parent organizations in the United States. Through representations made by the American commercial attaché to the proper officials, one company was authorized to remit approximately $65,000, while another was permitted to make an immediate transfer of $15,000 and regular weekly transfers of $3,000 thereafter. This action was sufficient to prevent further embarrassment in this connection.

EXAMPLES OF MISCELLANEOUS TRADE-PROMOTIVE WORK

A few more concrete examples of the trade-promotive work of the Foreign Commerce Service during the year under review will further illustrate the varied nature of its achievements.

On the initiative of the bureau's offices at Cairo and Prague, associations have been formed of dealers handling American automobiles in those two cities in order that they might act as unified bodies in developing and protecting their common interests.

The success of the trade commissioner at Batavia in persuading two prominent local business men to visit the United States and call at the bureau's San Francisco district office, on their way to the Netherlands, resulted in both of them establishing connections for the marketing of important lines of American products in the Dutch East Indies.

The Berlin office helped several long-established American proprietary-medicine houses successfully to establish distribution for their wares in the highly competitive German market.

Effective work was done by the commercial attaché at an important South American capital in combating propaganda against American trade. His public statements and written articles helped materially to counteract influences about to develop.

Timely advice by the Habana office that the Cuban Government intended to place that nation's dairy industry on a more sanitary and productive basis enabled American manufacturers to take advantage of the increased market for everything that goes into up-to-date dairying and milk distribution.

The Johannesburg office continued, as in the previous year, to combat anti-American propaganda. Numerous articles were contributed to the daily and trade press, and public replies to adverse propaganda were made.

Advance information from the London office concerning the movements of goods enabled American merchant ships, through the Shipping Board, to obtain important business.

The Madrid office was instrumental in obtaining the lifting of a Spanish ban against the exhibition of an American motion picture.

When a representative of the National Automobile Chamber of Commerce visited Uruguay the commercial attaché at Montevideo arranged a meeting of 450 individuals, comprising Government officials, automotive experts, road builders, manufacturers, educators, and other influential citizens, with whom the American representative discussed utility phases of motor transportation.

Among the subjects of surveys and reports by the Paris office were fisheries, iron and steel, chemicals, textiles, machinery, and agricultural implements. A report by this office on the European steel syndicate was characterized by an American steel-corporation official as "clearly the best thing which has come to this side, or perhaps I should say, it is the only really good discussion of a comprehensive sort."

The Prague office is preparing for an American pavilion at the fall semiannual Samples Fair. Participation of this country's manufacturers in this institution was initiated by the commercial attaché at the Czechoslovak capital in the spring of 1926. The American pavilion has become a conspicuous feature of an event attended by nearly 500,000 visitors—the only exhibit of its kind in central Europe. More than 50 American manufacturers have participated in each of the previous fairs, transacting business at the pavilion worth thousands of dollars and obtaining inestimable benefits in publicity.

The commercial attaché at Rome was an official delegate to the International Road Congress at Milan in September and, according to the chairman of the American delegation, "through his many contacts with the leading men in Italy he enabled us to obtain information which could not have been had otherwise."

The president of an American corporation asked the aid of the Stockholm office in obtaining the most desirable Swedish firm to manufacture electrical installations under secret plans owned by the United States concern. The plans were not protected by patent or copyright, and it was vitally necessary that the Swedish connection

be of absolute integrity. Through an introduction effected by the bureau's office a satisfactory connection was established and work was immediately begun on two large installations involving several hundred thousand dollars.

The Sydney office has taken every opportunity to induce responsible Australian business men traveling to England to include the United States in their itinerary. Letters of introduction to the bureau's offices in America are given to assist the travelers in getting in touch with American exporters.

Triweekly cablegrams and special reports from the Tokyo office assisted in the sale in Japan, from January 1 to April 1, of 20,000 tons of American rice. This office adjusted a dispute involving $600, between a New York university professor and a Japanese bookstore.

The Vienna office assisted the owners of the largest department store in the Austrian capital in opening a permanent exhibition of American household articles, such as electric and steam cookers, stoves, percolators, toasters, cooking utensils, washing machines, vacuum cleaners, and kitchen cabinets. The value of this exhibit, in "missionary work," is obviously very great.

The Vienna office obtained the release from the Austrian customs of two American motor busses held on a technicality. Not only was the sale of these machines saved but confidence of Vienna bus operators in the possibility of using American vehicles was restored.

SPECIAL REPRESENTATIVES ABROAD

The automotive trade expert in the Paris office of the bureau facilitated the selection of a European representative for an important American automobile company, and in the first three months of the connection more than $250,000 worth of cars were ordered. This trade commissioner also helped an American motor-car manufacturer to find a distributor for the Italian and North African territories.

This representative of the bureau cooperated with the official delegation from the United States to the International Road Congress at Milan and arranged a tour of eight European countries after the congress. On this trip the American delegation held conferences with government officials and highway executives in the countries visited, to whom they gave information on modern American methods of highway construction and traffic control.

The bureau's special grain representative for Europe has continued to direct considerable thought and effort to the devising of a more complete statistical picture of the movement of cereals in international trade. He has induced the principal authority compiling figures on international grain movements to conduct experiments with a view to presenting statistics on grain arrivals at European destinations, beginning with the new cereal year, August 1. "During the coming year," this representative reports, "efforts in this direction will not be relaxed, and if the European commercial agency is unable or unwilling to go beyond a certain point this office is prepared to assume the task of carrying the work through to a successful conclusion as a function of the bureau."

The services of the grain representative include a close check on the export movement of Russian grain, through the cooperation of the bureau's Constantinople office. Undue importance has been placed

on Russia as a source of supply, by European buyers who are constantly attempting to pass this conviction on to the American market. This bureau check-up, however, has supplied proof of Russia's limitations in the export field.

In the year under review the work of the bureau's special foodstuffs trade commissioner at London has doubled. This is due for the most part to the natural increase as the service has become better known. A considerable added volume of duties has been imposed on this representative during the last year in connection with reporting, the answering of inquiries, and informal negotiations with government officials concerning such questions as preservatives, merchandise marks, and net weights.

Growth of the fresh-fruit trade between American producers and English buyers has been a further notable justification for establishing this special foodstuffs service. One London fruit auctioneer reported business of nearly $200,000 with American shippers with whom he was placed in touch directly by the special trade commissioner.

Trade commissioners dealing specifically with the foodstuffs trade have been sent out by the bureau during the past year to various important markets for this type of commodities. Investigations in Argentina regarding the meat and oil industries furnished the bureau's foodstuffs division with much data of practical benefit to American interests.

A general survey of the east coast of South America is being made by one trade commissioner, and a large number of reports on the possibility of trade expansion there are coming in continuously.

The Mediterranean area is very important from the standpoint of foodstuffs, and the foodstuffs trade commissioner in that territory has provided much valuable information which has enabled interested manufacturers and exporters to gauge possible competition in America from foodstuffs originating in that region. Likewise, competition for American products in the Mediterranean area from European foodstuffs is now better understood in consequence of the investigations of this specialist. He has given special attention to crop prospects, harvests, stocks, opening prices, and other data with respect to dried fruits and nuts for all the Mediterranean countries.

The assignment of a special trade commissioner to the west coast of South America, charged with the development of the markets of that important territory for products of the United States, also has been highly productive. This representative not only visits capitals and metropolitan centers in the South American Republics but also penetrates to every town where a possible market for American products might exist. Many miles of his travels through the mountains have been on mule back, to places inaccessible by other means of transportation. He has discovered several very serious errors in the information on routing of merchandise, nearest banking centers, etc., as set forth in the publications usually accepted as commercial guides.

Through the direct efforts of the west-coast trade commissioner, the sugar mills of an important Peruvian concern have recently adopted California lime for clarifying their sugar. His information on textile-machinery opportunities has been of value to a Massa-

chusetts concern. Through his efforts an American manufacturing company was made aware of a practice employed by a salesman that represented it in South America last year, which was bringing the firm into disrepute; steps were taken immediately to remedy this situation.

SUBSTANTIAL RESULTS FROM DISTRICT-OFFICE SERVICE

Highly satisfactory dollars-and-cents results were achieved through the work of the bureau's district offices during the past fiscal year. Four hundred and five firms—out of a total of 20,640 served—reported actual sales and savings, effected through the bureau's efforts, to the amount of $9,718,330. The average per firm was thus $23,995. If the same average benefit per firm may be considered as applying to the clientele as a whole, the total would be over $484,000,000 worth of business obtained during the year as a result of these trade-promotive services.

It is worthy of note that the concrete benefit per firm reporting during the fiscal year just ended was nearly three times as great as during the preceding year—$23,995 as compared with $8,608. This, it is believed, may justly be regarded as a striking evidence of the organization's increased effectiveness.

During the past year six new district offices were established—at Galveston, Houston, Des Moines, Louisville, Memphis, and Minneapolis—making a total of 17 district offices. Five new cooperative offices were opened in commercial organizations in Beaumont, Tex., Greensboro, N. C., Lake Charles, La., Lowell, Mass., and Port Arthur, Tex.; this increased the number of cooperative offices to 34.

The number of commercial services rendered by the district offices mounted from 1,768,808 during 1925–26 to 2,192,597 for the fiscal year just closed—an increase of 24 per cent. During 1926–27 there were 73,781 callers, desiring information, as compared with 58,553 during the preceding fiscal year, while the number of letters written increased from 131,662 to 177,307. The district offices during 1926–27 gave out, on request, 571,766 sheets of "reserved information" on foreign-trade opportunities and in addition 537,117 lists of prospective foreign purchasers of American goods.

During the year a series of foreign-trade conferences were arranged through the district offices in a number of the larger cities in their territories, the purpose being to bring the bureau's services directly to the attention of business men. Such meetings were held in Boston, Providence, Houston, Erie, Galveston, Memphis, Atlanta, Louisville, New Orleans, and Detroit.

CREATING NEW INTEREST IN FOREIGN TRADE

One phase of the bureau's work, through the district offices, that seems worthy of special notice is indicated in a letter from a company in one of the "border States," which says that the recent establishment of a new district office in that territory "has encouraged concerns to embark on export trade which, lacking the facilities you offer, would otherwise have felt no inclination to do so." A statement of much the same character comes from a firm in the central West, which writes: "We question very much whether we would

have even started investigating foreign sales if it had not been for your cooperation." Still another company, manufacturing machinery, says: "Your office has not only given us a new vision of the possibility of making foreign sales but it has made the transacting of business with foreign countries easier than had seemed possible according to our previous notions of it, which were more or less hazy."

These expressions show clearly that the bureau, through its district as well as its foreign offices, is succeeding in one of its primary objects—that of making the great mass of American manufacturers "foreign-trade conscious." It has created interest where interest did not exist before. It has stimulated and revitalized foreign-trade endeavors that had previously been tentative or tepid. It has enlisted innumerable new firms in the effort to win foreign markets and has shown these firms, as well as other concerns experienced in the field, how to sell goods abroad most skillfully and satisfactorily, with a minimum of waste motion and a maximum of benefit to the individual and to American commerce as a whole.

UNIQUE AND DISTINCTIVE SERVICE PROVIDED

Numerous business houses, in letters to the district offices, emphasize the impossibility of individual firms duplicating or approximating such service as the bureau offers, and several companies mention figures showing the very large expense that it would be necessary for them to incur if they should try to do for themselves even a part of what the bureau is constantly striving to accomplish. For example, one of the best-known American motor-car companies says: "We feel that it would require at least one good man employed steadily, abroad, to obtain such figures as are supplied by your bureau—and, then, it would be more than a one-man proposition. It would cost at least $12,000 to $15,000 to maintain such a man in our service and pay his expenses." And each of the score or more exporting automobile companies would be compelled to do the same. In addition to the savings thus effected for the entire industry, there are many instances such as that reported by one company which states that "through the activities of the bureau this company has obtained approximately $30,000 worth of business" during the fiscal year just ended.

Another automobile corporation, writing to one of the district offices and referring specifically to the help afforded by an American commercial attaché in a foreign capital, has this to say: "Such a man's services to the American manufacturers who find a market for their goods in that country are of such value that it is difficult to estimate them in dollars and cents; but if we were asked to put a value on this commercial attaché's services to the American manufacturers we should rate them at $50,000 to $75,000 per year, and perhaps they would be worth a great deal more." It is worthy of note that the services of this commercial attaché actually cost the American taxpayers only $7,500 per year—or just one-tenth of their value as above estimated by the officials of the motor-car corporation. And the results of his efforts and investigations are available, free of charge, to all American business men through the district offices of the bureau as well as at the Washington headquarters.

EXPORT TROUBLES LESSENED OR ELIMINATED

The manner in which these branch offices throughout the United States eliminate much of the perplexity and trouble that formerly attended export effort is indicated by a letter addressed to one of the offices in the Middle West by a well-known firm making agricultural implements. "You will no doubt recall," this firm writes, "the old days when it was practically an impossibility for an interior merchant (and in a number of cases impossible for firms that had their offices on the coast) to make a shipment without first conferring with a number of their friends, and it was quite frequently necessary for them to visit the consuls of foreign countries before sufficient information could be obtained to permit them to make a shipment. This handicap has been eliminated by the information received from the bureau."

Testimony of much the same character is contained in the following letter from another concern in the Middle West: "Without such help as your district office has given us we would be practically against a stone wall in the formulation of our policies without years of study of the situation. We feel that you have saved our industry enormous expenditures which would have been necessary if your services had not been available."

That the services of the bureau's district offices are not only actively promotive but also "preventive" is evidenced also by the expression of a New England rubber company to the effect that "we no doubt were saved thousands of dollars and much anxiety by not making a certain agency appointment, on advices received from you; we were seriously considering the appointment at the time you furnished us this information."

PRACTICAL BENEFITS MOUNT INTO LARGE SUMS

As already indicated, large dollars-and-cents benefits reported to the district offices are numerous. A western flour company, for example, writes:

> Through use of the bureau's facilities, from March 15 to June 30, 1927, we have new contracts for approximately $2,000,000. We have used the bureau to the extent of approximately 90 per cent in our export department. Thus we have made trade connections in Norway, Denmark, and Finland (through the local district office); in Brazil (through the Rio office); in Trinidad and Barbados (through use of trade opportunities); and in Germany, Chile, Peru, Nicaragua, Costa Rica, Java, and China (by using trade lists). We have only used your bureau less than four months, and in this period we are in communication with approximately 2,500 buyers of flour throughout the world, and from this great number we are picking out our representatives.

An official of a rubber-products company writes: "I think there is no doubt but what our export business has been benefited $200,000 because of your services." Another firm reports to a district office a benefit of $100,000 during the past year, and the writer adds: "I feel that the amount of business we have obtained as above stated in consequence of the bureau's service is conservatively estimated." An engineering corporation writes that "your department comes in and renders help which is bound to result in enormous figures."

A very well-known American company, whose products are sold everywhere throughout the civilized world, writes as follows to a district office: "We can say that the Department of Commerce is

most essential to our business; we derive great benefits from it, and we are constantly requesting and receiving information regarding various territories." A chemical company in an eastern State has this to say:

We do not see how it is possible to figure in dollars and cents the tremendous advantages that have accrued to us through our studied use of facilities offered by the department. Through using the department's service we have obtained reliable information regarding the market for our product from almost every corner of the world, and if we attempted to figure out how much it would have cost us to send a representative to each of those regions we would soon tire of the task. The saving has been tremendous. Some of the information that we have obtained from abroad has been of inestimable value to us, and the reports of the representatives are usually clear-cut.

TYPICAL EXAMPLES OF PROMOTIVE ACTIVITY

To show in somewhat greater detail the character of the ordinary day-by-day services of the district offices, it seems desirable to list below a few examples of what one of those offices did during the fiscal year just past:

It assisted firms to collect at least $25,000 in claims which they otherwise would not have been able to adjust.

An engine works made a shipment of engines valued at $3,000 to a firm in Brazil whose name was furnished by the district office.

An alfalfa milling company has sold thousands of dollars worth of its alfalfa meal in European countries as a result of following up "leads" furnished by this office.

An American company secured orders for about eight carloads of oil in Europe in consequence of the office's cooperation.

An exporter of electrical supplies obtained orders for more than $3,000 worth of machinery from Mexico from prospective customers whose names were furnished by the bureau's office.

A firm of hardware exporters received an order for phonographs from Mexico as a result of a trade opportunity which the office referred to them.

A motor-car company was rendered assistance which prevented the unjust embargo of 10 cars by the customs authorities at a South American port.

A chemical company secured an order for 24 gallons of butter color as a result of writing to a list of dealers and importers in Latvia.

A company received an order for playground apparatus from the city of Iquique as a result of following up a trade opportunity supplied by the district office.

An engine company secured three orders for large semi-Diesel engines from Cuba from prospects whose names were furnished by the district office.

A hardware company secured some good orders as the results of placing their automotive catalogues in the hands of the bureau's foreign representatives—which was done at the suggestion of the district office.

Through the assistance rendered by the district office and one foreign office, a member of an automotive importing firm from Japan was induced to visit an American motors-company plant and placed several orders.

These are merely typical instances of what is accomplished in the routine work of a district office of this bureau. Similar results, along these and other lines, feature the work of all the offices in the bureau's organization within the United States.

CONCRETE COMMODITY SERVICE FOR AMERICAN INDUSTRIES

AGRICULTURAL IMPLEMENTS DIVISION

A firm in the Middle West manufacturing agricultural equipment writes: "Through information gathered from your reports we have made shipments of approximately $25,000 during the past year, and

we now have a shipment of about $4,000 which will go forward early next week." A tractor company gives $50,000 as the estimated amount of the export business that it secured in one year in consequence of bureau information. These examples illustrate the effectiveness of the service in this field.

The American agricultural-implement industry, during 1926–27, has been showing a greater interest in export trade than in past years, and consequently there has been a steady increase in the number of services rendered by the bureau in this field. The agricultural implements division at Washington has outlined export campaigns, given advice as to the most desirable markets, and (generally with the help of the bureau's foreign offices) assisted in the location and selection of agents. The personnel of the division compiled two trade information bulletins, entitled "Foreign markets for agricultural implements" and "Foreign markets for tractors," comprising a summary of the conditions prevailing in all the countries of the world.

The circulars issued by this division covered a wide variety of subjects. A series of "Implement and tractor notes" appeared at irregular intervals. The division prepared and distributed to manufacturers a summary of all available information on foreign markets for wheelbarrows. This was well received, and, during the coming year, the division plans to do the same for other minor commodities. Statistical statements were issued showing American exports of agricultural implements and tractors (1) by months, (2) for the first six months of 1926, and (3) for the calendar year.

The number of trade opportunities in this field increased 20 per cent as compared with the preceding year, about one-third of these being for agricultural implements in general. The largest numbers of specific inquiries were for tractors and for dairy equipment, and there were numerous others for such items as harvesting equipment, "combines," poultry equipment, fruit-handling equipment, spraying and dusting equipment, wheelbarrows, horse-drawn vehicles, etc.

In Commerce Reports various articles were published on the Italian trade in farm implements, while the conditions in Germany were also discussed in several articles. Other subjects included "Development of tractor trade in Hungary," "Tractor equipment used in Porto Rico," "Implement trade in the Irish Free State," "Stimulating the use of implements in India," "Implement markets of western Asia," "Danish market for tractors," "France as a market for American tractors," and "The use of tractors in Czechoslovakia." Other articles analyzed and discussed our exports of implements.

A questionnaire on foreign markets for tractors has been prepared and is ready to be sent out to the investigators abroad. Work has been started on a study of world markets for windmills. The bureau's representatives in Australia have begun the preparation of material for a bulletin on the market for agricultural implements and machinery in Australia.

AUTOMOTIVE DIVISION

"We sold directly to customers whose names we secured through your office 15 trucks, aggregating in value about $40,000," writes one American automotive company. A New York firm making automotive specialties says, "We feel safe in saying that your services have

probably netted us $15,000 worth of business." These instances are typical.

A marked increase of interest in export markets has accompanied the new records of production and foreign sales that were established in the fiscal year 1927 by American manufacturers of automobiles, parts, accessories, service equipment, motor cycles, marine engines, and aircraft. The bureau's automotive division has met the resultant need for an extension of its services. In September, 1926, a new chief of the division was appointed—a man associated with the automotive industry since its beginning in this country. Closer and broader working arrangements have been effected during the year with all of the principal national automotive trade associations.

The services to the automotive industry rendered by the bureau's offices in the United States during the past fiscal year totaled 214,806; those for which the Washington staff was responsible registered an increase of about 14 per cent over 1925–26. There was an increase of 451, or 32 per cent, in the number of the bureau's active automotive "contacts." Many of the inquiries which would ordinarily have been addressed to the bureau were "anticipated" by the automotive division's special services. For the Automotive Foreign Trade Manual (a loose-leaf reference library for the exporter) 1,435 new pages were issued—an increase of more than 20 per cent. There was an increase of about 35 per cent in the special circulars and bulletins issued, while the improved Automotive Foreign Market News Bulletin (issued weekly) was being read by 3,135 subscribers, 57 per cent more than during the preceding year.

The automotive reporting service by the Government's foreign representatives showed gratifying improvement during the year as the result of a better understanding on the part of the reporting officers of the requirements of the industry. Among the world surveys sponsored by the automotive division during the year were those entitled "Annual motor-vehicle census," "Markets for filling-station pumps," "Markets for aircraft and aircraft products," and "Markets for automobile servicing appliances." The results of these surveys are being made available to the industry in appropriate forms.

At the suggestion of the industry, special automotive trade commissioners, to look after automotive matters (including highway building and general transportation developments), have been appointed for Europe, South America, New Zealand, and India.

Two outstanding features of the year's work in this field have been the marked improvement in the collection and publication, periodically, of data on foreign automobile registrations, imports, exports, and sales (permitting the American exporter to follow sales trends closely) and the progress made in developing greater interest among American aircraft manufacturers in the possibilities of foreign trade.

CHEMICAL DIVISION

Through the bureau's direct efforts one American manufacturer sold $22,000 worth of insecticide sprays to Spain during the past year. This is typical of the success of the chemical division's trade-promotive activity.

In 1926–27, as compared with the preceding year, this division has rendered a greater volume of more valuable service. Inquiries of every character have increased. A greater number of executives in the chemical industry have visited the division. The division's weekly bulletin, in its new consolidated form, has aroused widespread interest; one paragraph in a recent issue brought in 88 requests for additional information on the subject under review. During the past year addresses have been made by representatives of the division before the National Fertilizer Association, the Manufacturing Chemists' Association, the American Drug Manufacturers' Association, and others among the 35 associations and societies within the chemical field.

The already existing statistical services of the division have been improved and extended so that American trade in certain important chemical items is shown in detail within a few days after the close of each month.

Several series of market surveys have been inaugurated with the purpose of promoting the sale of American chemical products abroad. These are issued once a week, covering a different world market in each instance. The classes of merchandise thus covered include paints and varnishes, plastics, dyes, medicines, toilet goods, naval stores, etc.

The chemical division has been particularly active in cooperating with several manufacturers of roofing and industrial paints, and results of real value have accrued. An especially interesting case is the development of an extensive and increasing demand abroad for American insecticide sprays. The division has worked on this subject continuously since insecticide sprays were first introduced abroad, with the result that there are now a number of American manufacturers exporting to most of the countries of the world.

To assist in ameliorating the condition of the fertilizer industry, efforts have been made to promote sales in foreign countries. Much attention has been given to following the development of important competitive products in Germany, especially atmospheric nitrogen and other synthetic products which are originating there in increasing number.

"Ma huang," a crude drug of Chinese origin, has recently attained great importance in American pharmacy as the source of a valuable substance in our materia medica. Through the bureau's activities, the important manufacturing druggists of the country have been placed in direct touch with the original sources of supply in China. In like manner the bureau has developed to a useful commercial conclusion the gathering, shipping, and utilization of derris root in the Orient, this being a highly active principle in the manufacture of insecticides.

The bureau's special cable service covering conditions in China pertaining to tung oil has proved most efficacious during recent unsettled conditions in the vicinity of Hankow, China, through which port most tung oil is exported. Buyers in the United States, in the manufacture of whose products this oil is essential, have been kept fully informed of developments affecting shipments and market conditions, with the result that there has been no serious interruption

to business and all unforeseen or excessive price fluctuations have been eliminated.

Raw materials under foreign control have continued to receive particular attention, especially in the case of nitrogen, potash, iodine, camphor, and quinine. Cooperation has been extended to the War Department in studies on opium, nux vomica, camphor, iodine, and quinine. There has also been cooperation with the Treasury Department in the field of alcohols and denaturants and with the National Committee on Wood Utilization in the matter of the chemical utilization of waste wood.

Of outstanding significance during the past year was the conference of chemical executives held in Washington in December under the auspices of the chemical advisory committee to the Department of Commerce. This conference was attended by 200 high executives of many of the leading chemical firms in this country. Its object was to outline in detail the work of this bureau, so that the visitors might realize fully the facilities which are here readily available. That the meeting was extremely successful has been universally attested.

FOODSTUFFS DIVISION

One Pacific coast firm exporting foodstuffs reports $40,000 as the value of new business which it obtained through the use of this bureau's facilities from July 1, 1926, to June 30, 1927. "Of great help" and "very valuable services" are among the comments by this company which are echoed by many others in the foodstuffs trade.

The special trade news announcements of the bureau's foodstuffs division for the year just past amounted to 2,766 pages, as compared with 2,053 pages for 1925–26, or an increase of about 34 per cent. The outgoing mail totaled more than 21,000 letters.

The canned-foods survey begun in July, 1926, was carried out, and a preliminary report was made. This survey consisted of collecting by personal interviews the opinions of housewives to determine what objection or prejudices they may have against canned goods. About a thousand interviews were secured, largely in Brooklyn, N. Y., Bridgeport, Conn., and Sussex County, N. J. Apparently many industries are now considering the value of surveys of this or somewhat similar character, as a means of improving advertising and distribution.

The division has endeavored, during the year, to complete (and bring up to date) its statistical work, as well as its lists of exporters and importers. Contacts have been established with new firms, and the division is now in touch with between 7,000 and 8,000 individual concerns. There has been considerable expansion in the mailing list of Foodstuffs 'Round the World, particularly in the tobacco, confectionery, and tropical-products sections. The foodstuffs bulletins published during the year included International Trade in Coffee, International Trade in Dried Fruit, Rice Trade in the Far East, and Palm-Oil Industry of Sumatra and West Africa.

ELECTRICAL DIVISION

"The assistance of the bureau has been instrumental in helping us to get at least $50,000 worth of business during the last six months, and we know that the future volume of such business will be very substantial." In these words a well-known company making electric refrigerators indicates the concrete value of the bureau's service in this line. Among the numerous other electrical firms testifying to similar results is one in the Middle West, which says, "With data given us by your department we have shipped about $10,000 worth of merchandise to foreign countries since January 1, 1927."

Manufacturers of portable electric tools, motor-control apparatus, and the like found themselves in need during the past year of authoritative data on regulations of central stations affecting the use of their equipment. The bureau's electrical equipment division has collected the available data of this character from all parts of the world, and an analysis is being prepared for publication. Broadcasting laws and regulations affecting the sale of radio instruments have been procured and compiled by the division.

The collection and dissemination of data on characteristics of electric current continued throughout the year. This work was begun in 1921, and the division has been able to supply needed data for all parts of the world in response to numerous and urgent requests. During the past year the material covering Africa, Oceania, and the Western Hemisphere was published in the form of trade information bulletins. The remainder of the world, Europe and Asia, will be covered by other bulletins.

Compilation of basic data on electrical markets, following a selected outline approved by the industry, was begun early in the fiscal year. One publication, covering Australian markets, has already been released, and 17 others are in course of preparation.

The division has continued to facilitate the distribution in the United States of the specifications of the Victoria (Australia) Electricity Commission. A large number of specifications of the Australian Commonwealth Post and Telegraph Department were made available through the bureau's New York and Chicago district offices. Porto Rican Government specifications were received and made available as issued.

A weekly bulletin was inaugurated by the electrical division to make possible a more effective distribution of miscellaneous material. Special efforts were made to aid in building up the export trade of companies whose lines were not being generally pushed—an example being electrically operated fire doors. Information was prepared on domestic sources and characteristics of cobalt steel magnets, particularly as applied to the radio industry. Data on the number of electrical consumers in the world were collected from the foreign offices, and an article embodying the results of this survey attracted widespread attention both in this country and abroad. Special efforts were put forth by the bureau to encourage the trade in radio equipment, to relieve the domestic market of surplus production and to smooth out the "curve" of production and sales. Statistical studies of market trends of radio and other seasonal exports were made and the results published. Material concerning the operation and status of power plants in a number of foreign countries was made available to various American firms.

HIDE AND LEATHER DIVISION

A New York leather company states that its sales to foreign markets during the past year have increased by almost $1,000,000, about 15 per cent of which was due to the aid extended by the bureau through the hide and leather division.

In consequence of this division's recommendation of agents, three tanners say that their sales during the year to various South American countries have been increased by $12,000, $19,000, and $22,000, respectively. These are representative examples of the service in this field.

The number of trade inquiries and service letters handled by the hide and leather division during 1926–27 was exactly double the number for the preceding year. Because of the intensive work in foreign fields, there was a 40 per cent increase in the number of oversea trade opportunities submitted for the benefit of American industry. Services to visitors increased 15 per cent. Cooperation with the industries, collectively and individually, has been developed to a high degree. Exchange of agency information among members of the industries, through the division as a clearing house, has become one of the most important services. The division has encouraged the holding of frequent round-table meetings of leather export managers in New York, Boston, and Philadelphia to their mutual benefit.

The hide and leather division's Export Manual, which has proved most valuable, was distributed to subscribers in October, 1926; one of the important tasks of the division is to keep this manual revised. A cable service from the foreign field has been amplified under the direction of the advisory committee of the industry. At the request of the industry, an expert leather trade commissioner for Europe was obtained and spent the last two months of the fiscal year in training at Washington; he will leave for his post shortly after the beginning of the new fiscal year.

The hide and leather division is helping to interest buyers in reindeer skins from Alaska. It has developed, during the year, its cooperation with other Government organizations, including the Quartermaster Corps (on leather procurement), the Bureau of Standards, the Bureau of the Census, and a number of the bureaus of the Department of Agriculture. The interdepartmental committee for the study of problems relating to the conservation of domestic raw stock (composed of representatives of the Departments of Agriculture and Commerce) has been very active during the past 12 months and expects to expand the scope of its work very materially during the coming year.

Among the publications of the division was a handbook entitled "Hides and Skins: World Production and International Trade," which, it is believed, will prove very helpful as a source of facts not readily obtainable elsewhere.

IRON-STEEL-HARDWARE DIVISION

The New York office of a firm manufacturing iron and steel products states: "We can conservatively estimate that, as a result of carefully perusing the various reports issued by the Bureau of For-

eign and Domestic Commerce, we have received approximately $100,000 worth of business." And a firm in the hardware line writes: "Our export sales for 1926 were about $130,000; these were largely the result of mailing to lists furnished or confirmed by statistics from your bureau." In such eminently practical ways as this our organization aids the iron, steel, and hardware producers of the United States.

The past year has seen a marked expansion in the American export trade in iron and steel and a well-maintained trade in hardware and allied products—conditions which may be attributed, at least in part, to the activities of the bureau's iron-steel-hardware division, which has been especially active (among its many other efforts) in furthering the foreign sales of steel-frame houses, rails, tin plate, piping, metal lath, steel sash, hand tools, plumbing fixtures and fittings, cooking and heating appliances (including oil-burner equipment), lamps and lampware, and abrasives.

The chief of this division, as a result of his personal visits to the important iron and steel producing centers of continental Europe and Great Britain, was enabled to present to the American industry a definite statement indicative of the true competitive ability of these foreign producers in the world's markets when opposed to American products, and in numerous instances he has allayed the fears of those who believed that we had no chance in that trade in the future. Further, he was in a position to encourage certain domestic steel manufacturers operating at coastal points to continue their efforts in combating the importation into their territory of cheap continental products.

The publications of this division greatly increased in number as compared with 1925–26. In all, 256 circulars were issued during the fiscal year 1927. The trade information bulletins included those entitled "Foreign Markets for Plumbing Supplies," "Iron and Steel Trade and Industry of the Netherlands," "Origin and Development of the Continental Steel Entente," and "British Market for Hand Tools." The division also prepared a directory of the leading iron and steel manufacturers and fabricators of the United States.

The division's statistical work was very materially expanded during the year. In addition to the monthly analyses of imports and exports prepared for general publication, and an increasingly large number of replies to requests for specific data, 13 distinct analyses of the import and export trade are prepared monthly and transmitted to 60 interested "contacts."

One of the outstanding services of this division in its relations with American manufacturers is its extensive monthly analyses of our iron and steel imports—analyses which not only disclose the sources from which these products come but which also show the areas of the United States that they enter.

LUMBER DIVISION

The lumber division's agency service alone has been worth many thousands of dollars to American lumber exporters during the past year. The division has arranged a great many connections between such exporters and suitable foreign agents, and the expense of

arranging the connection would have averaged at least $1,000 in each instance if the exporter (or some one representing him) had gone abroad for this purpose. In addition, this service has operated to avert undesirable connections, which would have cost heavily. A record kept from March 20 to June 30 of the present year shows 316 agency suggestions made to about 100 lumber exporters.

The bureau's lumber trade commissioner in London has completed a handbook on the lumber trade of the United Kingdom. The lumber trade commissioner in the Far East has prepared a comprehensive report on the Japanese lumber market. Both have submitted valuable current reports, assisted in adjusting claims, and otherwise aided the American lumber trade.

The lumber division at Washington has maintained close cooperation with the National Committee on Wood Utilization, resulting in greatly improved service as to lumber marketing.

Besides a weekly section in Commerce Reports, many valuable reports have been released to the lumber press. Current trade information went to lumber firms in the 307 mimeographed "subject circulars" issued by the lumber division and the 105 weekly or semiweekly circulars to the Pacific coast section of our export lumber trade, issued through the bureau's western district offices. The circular service covers all export lumber and timber products, including such items as veneer and plywoods, railroad ties, small dimension stock, cooperage, and box shooks.

Special attention has been given to important matters such as the Japanese lumber trade, agency conditions in Cuba and Argentina, and cork for refrigeration insulation. Assistance to exporters includes the checking (through the bureau's field offices) of claims by foreign buyers; this service involves only examination and advice to the American firm, without actual adjustments.

Trade information bulletins issued under the auspices of this division covered the lumber trade of Australia, the cooperage trade of Great Britain, and the Parana pine industry of southern Brazil.

MACHINERY DIVISION

Fifty-five thousand dollars is the estimate by a firm of Pacific coast machinery manufacturers of the value of the new business obtained by them during 1926–27 through utilizing the facilities of this bureau. Many other machinery companies have profited in like manner to a greater or less degree.

The bureau's industrial machinery division in its work of promoting American machinery sales abroad has enjoyed an intimate contact with various manufacturers who consult with the division personally and by mail regarding their export problems. The division has cooperated with several foreign delegations visiting the United States—notably the group that was preparing for the International Exposition to be held in Seville, Spain, and the Industrial Commission from Australia that was in this country for several months. Construction projects in foreign countries have been closely followed; American interests have been given the benefit of the resulting information in the furtherance of their sales and also in the

facilitating of contracts for American firms that are in a position to handle such business. During the year much of the division's material has been revised, particularly the reports covering machinery dealers in all important foreign countries, the collection of foreign boiler laws, and similar data.

MINERALS SECTION

Fifty thousand gallons of oil, valued at more than $200,000, were sold within a period of 60 days during the past year by a firm in Oklahoma as a result of service rendered by the minerals section of the bureau, working in cooperation with several of the field offices.

The British coal strike, which ended in November, 1926, accounts for the tremendous increase in the exports of American coal and coke during the fiscal year 1927, amounting to 36,714,000 long tons, valued at $207,400,000, as compared with our exports for 1926 of 20,573,000 long tons, valued at $111,200,000. American exporters of coal are few in number and the markets are ordinarily limited. The strike brought a constant flow of orders from consuming nations previously supplied by Great Britain. Producers entered the export field who had previously not been interested in foreign markets. The minerals section of this bureau, by inaugurating special midweekly and weekly cable service between the bureau and the principal European and Latin American markets, and by compiling and promptly distributing detailed market data based on such cablegrams and complementary mailed reports, served American coal producers and exporters in such a manner that the latter have recognized this assistance as a notable factor in the increased business resulting primarily from the British strike.

The problem of foreign competition in the American cement market resulted in the appointment of a cement specialist in the section, who secures, prepares, and disseminates current information relative to the output, exports, and prices of cement produced in the principal cement-manufacturing countries. Current foreign-market analyses are prepared for release.

American consumers' dependence on China for antimony, and the internal complications in that country, made it advisable for the mineral section (acceding to the demands of the trade) to establish a 10-day cable service between the bureau and Government representatives at Changsha, Hankow, and Shanghai. These cablegrams contain statistics covering production, stocks, movement, and prices of antimony for the current 10-day period. Inaccurate information on these subjects accounted for the great fluctuation in the price of antimony during the fiscal year 1926, when the lowest monthly average price was $0.11106 per pound c. i. f. New York and the highest $0.23490 per pound. During the year 1927 the lowest price of the metal was $0.12447 and the highest $0.15957. Statements from the trade indicate the efficacy of the bureau's service in providing as nearly accurate information as can be obtained, which in itself prevents wide fluctuations in the market price.

The trade information bulletins issued under the auspices of the minerals section included Asbestos: Sources and Trade, Coal in Europe, and Petroleum Refineries in Foreign Countries.

PAPER DIVISION

The number of inquiries on foreign markets for paper and paper products, and on the conditions influencing those markets, answered during the past year by the bureau's paper division was 21,861, an increase of 24 per cent over 1925–26. Manufacturers of paper and board products of all kinds received active assistance in finding markets abroad and were informed regularly of economic and commercial changes affecting sales possibilities.

The investigation of markets abroad for printing machinery, accessories, and printing and lithographing inks was completed, and most of the data were published and distributed. The detailed survey of the pulp and paper resources, production, and trade of the world's producing countries was brought nearer completion, and most of the results have been made public. There was a special survey of the pulp and paper industry and trade of Canada. The survey of the boxboard, box, and carton industry and trade, begun last year, has been nearly completed, and the results will be published as soon as possible. Assistance was given the American Paper and Pulp Association in preparing a complete tariff history of the industry in the United States since 1789.

The latter part of the year was noteworthy by reason of increased demands for information bearing upon problems of distribution and consumption, both domestic and foreign, and also for material on new developments in the industry in North America and Europe. The paper division has made special efforts to help American manufacturers to find suitable representatives abroad, and a number of new "contacts" were made for manufacturers not previously interested in exporting. An endeavor was made to interest American printing-equipment concerns in the Italian market, which has heretofore been dominated largely by the manufacturers of central Europe. Several firms making special qualities of printing and lithographing inks were also assisted in finding markets for their products.

Trade information bulletins published under the auspices of the division complete the series on markets for paper and paper products in Latin America and also cover portions of Asia and Africa. Four special informational services were inaugurated in cooperation with trade associations.

RUBBER DIVISION

It is worthy of note that, during the period of the rubber division's activities, the value of the exports of rubber goods from the United States has increased from $34,009,308 in the year 1922 to $59,868,812 in 1926.

The volume of work accomplished by this division during 1926–27 represents, roughly, a 35 per cent increase over the preceding fiscal year. The personnel remained the same, the greater volume being attained through careful supervision and the introduction of more effective methods. The export services of the division consist of bringing to the attention of exporters opportunities to develop their foreign trade and keeping them informed concerning trends and growth of trade in specific commodities with individual countries.

During the past year the rubber division has instituted three news letters (one weekly and two monthly), serving, respectively, the exporters of tires, mechanical rubber goods, and rubber footwear. The series of manuals containing facts affecting the importation of rubber goods into foreign markets was extended by the issuance of the manual on mechanical rubber goods—this covering 100 markets. This work of organizing in manual form the basic market information on rubber products will be completed with the manual covering druggists' rubber sundries and specialties, preliminary work on which has been completed. These manuals and those on tires and footwear, previously issued, are to be revised periodically. A trade information bulletin, entitled "Export Trade in Rubber Footwear, 1925," was also released, providing current information concerning the growth in this branch of export trade and the competitive position of the United States.

The crude-rubber services of the division, which constitute an increasingly important phase of its work, consist in keeping the trade fully informed with respect to international trade in this commodity—exports from producing countries, imports into manufacturing countries, and developments in connection with restriction of rubber exports. The last two rubber-survey reports, Possibilities for Para Rubber Production in Northern Tropical America and Production of Gutta-Percha, Balata, Chicle, and Allied Gums, were released during the year. The report on Marketing of Crude Rubber is being revised and amplified, the chief of the division having personally visited European crude-rubber marketing centers to obtain the desired data. The report will be published during the first half of the current fiscal year.

A survey was made of the American production and consumption of reclaimed rubber during 1926. A regular service established during the year is the dissemination of cabled reports on weekly movements of crude rubber from the principal foreign trade centers. The tire-dealers survey, taken semiannually, was continued, to provide necessary data to aid manufacturers in fixing production schedules; in this the industry cooperates with the division through the Rubber Association.

SHOE AND LEATHER MANUFACTURES DIVISION

A saving of about $11,000 on a single contract for Army footwear may justly be attributed to the expert advice furnished by the shoe and leather manufactures division of this bureau. Similar savings have been brought about in connection with numerous other purchases of leather goods by the War Department, which consults this division on the best time to place bids for shoes, gloves, leather belts, Army lockers, etc.

The activities of the shoe and leather manufactures division largely increased over the preceding year and were handled without any augmenting of the personnel. About 80,000 pieces of mail were sent out (including general correspondence, circular letters, statistical statements, foreign-markets bulletins, etc.), representing a considerable gain over the fiscal year 1926. Moreover, the general correspondence of the past six months has showed an increase of 32 per cent over that for the first half of the fiscal year.

The division issued trade information bulletins covering the methods of manufacture of boots and shoes in foreign countries as well as the foreign-market possibilities for trunks and other luggage, leather belting, pocketbooks and purses, and miscellaneous leather goods—the necessary data having been obtained by consular officers and the bureau's own representatives in foreign countries.

An Exporters' Ready Reference Handbook—containing important information relative to the area, population, language, climatic conditions, topography, leading industries, etc., of the principal consular districts in foreign countries—was compiled and distributed to aid exporters in the selection of suitable markets for their manufactured products; this has been well received and has proved most helpful. A second edition of the Directory of the United States Exporters of Leather Manufactured Goods was published. The division, during the year, established contact with about 230 additional exporters and, of these, added to the bureau's Exporters' Index 159, with invested capital of approximately $159,000,000.

Many requests relating to production and the import and export trade in commodities handled by the division have been received from manufacturers, trade associations, and editors of trade publications; the replies to these have involved a great deal of original and research work, commercial analysis, and the preparation of graphic charts. The division has continued its close cooperation with the various advisory committees and trade associations. The chief of the division has, by request, attended a number of conferences in various parts of the United States, where were discussed many problems relating to the industry and trade and advice was given as to the selection of potential markets, the most effective methods of distribution, and sales promotion abroad.

The bureau, with the close collaboration of the trade, has recently appointed an assistant trade commissioner who will, in the fiscal year 1928, investigate in Germany the boot and shoe and allied industries, with the view of promoting the exports from the United States of these commodities.

SPECIALTIES DIVISION

The direct-sales service rendered during the past year by the specialties division showed very satisfactory results, and American specialties manufacturers reported orders received through this service in amounts ranging from $100 to $10,000. One contract alone, obtained by an American office-appliance firm with a foreign state railway, resulted in the placing of equipment amounting to approximately $6,000 per year. Playground apparatus, toys, scientific and professional instruments, business equipment, and numerous other commodities figure in this special service.

Since the organization of the specialties division early in 1921 it has always stressed this merchandising service, consisting of specific sales "leads," assistance in planning foreign sales campaigns, and the extension of existing markets for American-made specialties. As the division is concerned with promoting foreign sales of more than 20 major groups of commodities—including (besides those mentioned above) such diverse classes of merchandise as furniture, glass, novel-

ties, motion pictures, printed and lithographed matter, etc.—it can readily be seen that its clientele is extremely large and of a highly specialized character.

The importance of the specialties trade as a whole is quite apparent when it is considered that during the calendar year 1926 $167,048,676 worth of American specialties were exported, representing an increase of more than $11,000,000 over the preceding year.

The past year established a new record in the services rendered by the division to the industries coming within its jurisdiction. In the last six months of the fiscal year 1926–27, 5,442 inquiries were received pertaining to the specialties field, which figure exceeds the total for any previous entire year. The volume of the work in general showed a proportionate increase.

In addition to the service afforded to American manufacturers of specialties the division maintains an export-advertising service and also keeps in touch with the activities of export merchants, commission houses, and allied enterprises, with a view to aiding this important element in our export trade.

A new step in the division's service to all of these groups has been the publication of a foreign-market bulletin, appearing at more or less regular intervals and giving them the benefit of the great mass of foreign sales and market data which formerly it was difficult to distribute to the interested trades through the usual channels.

Besides the services carried on from the Washington headquarters, the division has also maintained a more direct contact through conferences and visits by bureau representatives to many of the leading trade and manufacturing centers in the United States. This phase of its work has been unusually valuable in bringing about a better understanding of the problems confronting the industries and business interests that it is trying to serve.

The usual close contacts have been maintained with the various trade associations coming within the specialties field.

The division, with the assistance of the bureau's field staff and the consular officers, made numerous special studies covering foreign markets for a wide range of American-made specialties. The results of many of these studies have been published as foreign-market bulletins, trade-information bulletins, and special circulars.

One of the features of the work of the specialties division is its export-advertising service. The growth in trade and the international flow of money can be reduced to figures, but under existing conditions no such means exist for measuring trends in export advertising. However, judging from the expressed opinion of advertising managers and agencies engaged in placing such business and from the number of inquiries on the subject coming to the specialties division, it would appear that the volume of advertising in foreign countries must be increasing now at a more rapid rate than the trade totals themselves. And it is only logical to assume that during the next decade there will be a vast increase in the advertising abroad of products designed for individual consumption.

The bureau has undertaken to offer certain services to American firms interested in the problem of expanding their foreign sales through publicity. The specialties division has collected data on the methods, media, and other facilities available to the American adver-

tiser in all foreign countries, and the division is able to render effective assistance in connection with most foreign advertising problems. It must be emphasized, however, that the service offered is one of giving facts rather than professional advice, the latter being a function of the professional advertiser or of the advertising agency. It should be noted that an increasing number of advertising agencies are interesting themselves in the subject and that an impressive number of such establishments are to-day in a position to provide for their clients an intelligent and capable service in oversea fields.

During the last year the number of foreign publications concerning which information is available in the specialties division has increased from less than 4,000 to approximately 10,000. Special studies have been made—such, for example, as those of poster advertising in Germany, France, and England and of motion-picture advertising in Latin America. In conjunction with the automotive division two trade information bulletins on the advertising of automotive products have been published, and a third is nearing completion.

In May there was initiated a means by which news of special interest to advertisers could readily be made available periodically to those firms which in recent months have requested such service, as well as to the bureau's district offices. The division prepared a special mailing list which includes trade associations, advertising agencies, individual manufacturers, and publishers of journals devoted to advertising. This service takes the form of a foreign-market bulletin on advertising abroad, with no regular interval between issues but with the expectation that 10 or 12 numbers per year will be sent to the rapidly growing mailing list.

The motion-picture section was officially organized on July 1, 1926, and, considering the short time that it has been established, its achievements during the past year are really notable. More than 2,700 inquiries were received from the trade. The number of inquiries increased nearly one-third after March 15, 1927.

Two trade information bulletins, four foreign-markets bulletins, and a large number of articles were published on the motion-picture trade. Also, a special weekly press service was inaugurated last September under the title "Worldwide Motion-Picture Developments."

A special study of motion-picture theaters in all foreign countries was made, including all the pertinent facts concerning theaters now in use and an estimate of theaters under construction. Similar studies covered short subjects and industrial films. The bureau's European offices were instructed to furnish monthly a brief résumé of film conditions in their respective territories. The data thus obtained were used more or less as a basis for the section's weekly press service.

A considerable amount of special work by the motion-picture section included the preparation of detailed information on all foreign markets for the Film Yearbook (published by the Film Daily), which ran it as a special section of more than 75 pages. At the request of the Secretary of Commerce, the bureau obtained from all the news-reel companies pictures covering scenes of the Mississippi flood, for the permanent files of the department.

The section furnished to a well-known investment house in Chicago data which were used as the basis for a booklet entitled "The Motion-Picture Industry as a Basis for Bond Financing." Close

contact has been maintained with the motion-picture trade associations, both by correspondence and by special conferences. Likewise, the section has maintained close relations with the motion-picture divisions of other Government departments and on a number of occasions has secured films from these sources for special showing abroad. A greatly increased interest in industrial films has made it necessary for the section to start a study of this field, and plans have already been made to compile accurate lists of the industrial films available in this country, together with full information as to the methods by which they may be distributed abroad. The interest in motion-picture equipment has also greatly increased, and the section is planning to cover this field during the coming year.

A special motion-picture trade commissioner was appointed early last August and in September established his headquarters in Paris. His mission is to survey film conditions in Europe and to observe closely any agitation or legislation against American pictures. During the past year he visited a large number of the leading motion-picture trade centers in Europe, and as a result of his investigations he submitted 176 reports and kept the section at Washington fully informed on the motion-picture trade in that area. In addition to his other duties, this trade commissioner maintains close contacts with the various motion-picture interests in Europe and gives all possible assistance to the officers of American companies who travel in that area. It is readily apparent that this kind of service to the American motion-picture trade is of inestimable value.

TEXTILE DIVISION

The textile division was especially active during the past year in its efforts to promote foreign trade in yarns, hosiery, bathing suits, knitted outerwear and underwear, corsets and brassieres, hats, ready-made wearing apparel, and haberdashery, not to mention numerous staple lines for which a substantial export demand already existed. There has been a considerable aggregate of trial orders for the aforementioned commodities from new foreign customers, and they constitute an "opening wedge" which should result in an increasing volume of business later.

When the unusually large cotton crop forced raw-cotton prices below production costs, the chief of the textile division was active in initiating concerted action among leaders in the cotton trade to find ways and means of preventing financial ruin to cotton growers—particularly through price stabilization, extension of the uses of cotton, and the finding of new markets for American cotton goods. The chief of this division also rendered considerable assistance to the Cotton Textile Institute, an organization representing the first definite attempt of northern and southern cotton manufacturers to cooperate in solving some of the major difficulties of the cotton-manufacturing industry.

At the request of the rayon branch of the Silk Association of America, the textile division inaugurated a very comprehensive monthly statistical analysis of rayon imports, showing qualities, deniers, countries of origin, prices, etc., of rayon yarns imported. This has proved of considerable value to rayon producers and consumers in the United States.

Important services of this division in effecting governmental economies (and aiding American industry) through cooperation with other departments have been mentioned earlier in this report (p. 78).

SPECIALIZED TECHNICAL SERVICES TO BUSINESS

COMMERCIAL INTELLIGENCE DIVISION

"We have increased our export business just 20 per cent during the past year as a result of the cooperation of your office," a New York exporting house writes to the bureau's commercial intelligence division at Washington. And an Ohio manufacturer says: "You have helped us to double our volume of export business during the past year." These expressions serve to illustrate the value placed on the division's efforts by the firms that it aids.

The commercial intelligence division may well be regarded as the bureau's clearing house of information regarding merchandise buyers of all types in the oversea markets. A very active file maintained in this division now contains detailed reports on approximately 300,000 foreign business concerns; many of these are now buyers of American products, others are prospective purchasers and good sales contacts, while there are also reports on foreign firms that fall into quite another class. To this file there were added, during the fiscal year just closed, more than 42,000 reports. These World Trade Directory reports are in great demand. They are furnished only to registered bureau clients, upon request. A striking evidence of the growth of this service is the fact that during the fiscal year 1926–27 the bureau received requests for 72,439 reports of this character, as compared with 11,684 for the fiscal year 1920–21—representing more than a sixfold increase in a six-year period. These reports are kept current not only by revisions from the field but also by supplemental information received from business concerns in this country, as well as banks and commercial organizations, whose cooperation is invaluable.

Much of the value of this service lies in the ability of the bureau to supply detailed and pertinent information on foreign business concerns located in the smaller and more obscure trade centers, as well as in the large commercial centers of the world; and this is made possible by the excellent work of the foreign field staff of the Department of State, who supplied a large part of the reports embraced in this file.

Much progress has been made during the past fiscal year in standardizing the lists of foreign importers and dealers in various commodities. To make such lists more useful, main commodity groups have been subdivided to suit the specific needs of American exporters. During the past fiscal year there were distributed from the Washington office of the bureau 134,556 of these commodity dealer lists and from the district and cooperative offices 537,144, making a total of 671,700—an increase of about 9 per cent over the preceding fiscal year. In addition to the multigraphed lists, it was necessary last year, in serving bureau clients, to compile and type more than 7,000 special lists. Much work is involved in the checking and revision of the trade lists after publication to keep them accurate and up

to date. A great deal of credit is due the Consular Service of the Department of State for new material supplied for these trade lists and for corrections to lists that have been published. An effort is made to revise such lists in the field every 12 months.

Another service of the commercial intelligence division which has proved very helpful is that of suggesting, in individual cases, suitable foreign sales agents to handle merchandise lines in a territorial division on an exclusive sales basis. This work requires much care and research. Many bureau clients have reported that, through this service, they have concluded satisfactory and profitable connections.

This division makes the first checking on foreign trade opportunities received from the field, in an effort to determine the reliability and general standing of the inquirers prior to the publication of such trade opportunities to American business concerns. Opportunities checked through the division during the past fiscal year numbered 6,227.

To a considerable number of banks in this country the commercial intelligence division reports foreign concerns and individuals that are said to be resorting to objectionable business practices—also reporting firms in foreign countries that are involved in financial difficulties, failures, liquidations, etc. Confidential reports of this character are made bimonthly and have been found to be a valuable aid in making exporting safer for American business men.

DIVISION OF COMMERCIAL LAWS

The principal object of the division of commercial laws is the protection of American firms engaged in foreign trade—through dissemination of information regarding foreign commercial laws, taxation, insurance, patents and trade-marks, and through the adjustment of trade difficulties and the endeavor to remove their underlying causes. It should be clearly understood that, in its service with respect to foreign commercial laws, the bureau does not in any sense supplant American attorneys. Its work along this line is merely supplementary to that of our lawyers who handle cases abroad and are interested in foreign procedure. In very many cases the bureau provides direct and concrete help for them. Some of the most cordial commendation of the division of commercial laws comes from attorneys who avail themselves often of the data which it is in a position to furnish. Few lawyers in this country possess full knowledge of the infinitely complex legal systems of foreign countries, and they regard with approval the maintenance in this department of a fund of information of this character—information that they might otherwise have the utmost difficulty in obtaining. Far from diminishing their practice, the bureau's service in this respect tends to increase it materially, and enables them to proceed in each case with greater confidence and a larger prospect of success.

The section of legal information maintains current data relative to the commercial laws of all foreign countries—approximately 1,800 files, covering such subjects as agency; banking; bankruptcy; contracts; corporation law; negotiable instruments; powers of attorney; real property; sales documents; and trade restrictions, customs, and practices. Within the past year special study has been

given to exclusive sales agreements, conditional sales, and hire-purchase contracts. A series of publications on trading under the laws of various foreign countries has been continued. Trade information bulletins published include those entitled "Protesting Drafts in Germany, Austria, Hungary, Switzerland, Danzig, Czechoslovakia, Bulgaria, and Rumania" and "Bills of Exchange: Practices in Foreign Countries Regarding Payment-on-Arrival Bills." The monthly issue of the "Comparative Law Series" has been of particular interest to the legal profession.

The tax section, having made exhaustive studies of the principles of taxation systems in many foreign countries, especially with reference to American firms doing business abroad, now maintains current information regarding the development and application of laws and regulations. Relative advantages of different methods of doing business have been studied, the subjects of particular moment being establishment of agencies, branches, or subsidiaries of American organizations; registration, licensing, or incorporation; taxation, and reports required. During the past two years a member of the division has spent considerable time in the more commercially important European countries investigating these subjects, the information thus obtained being made available through current reports and publications relative to "doing business" and "taxation affecting business" in different countries.

The trade-mark section has systematically expanded (to include all commercially important countries) its services of protecting American exporters in their industrial-property rights through discovering, investigating, and reporting piracies. Current information is maintained on the subject of patents, trade-marks, copyrights, and unfair competition. Names of foreign attorneys specializing therein are on file. Prompt and practical assistance has, on numerous occasions, been rendered to American firms. Cooperation with the motion-picture industry has practically eliminated piracy in this field. As an indirect result of the section's activities, copyright conventions have been concluded with Poland and Czechoslovakia in addition to those countries already signatory to such agreements.

Current information regarding insurance laws of foreign countries has been furnished by the insurance and trade-claim section. Statistics on life insurance throughout the world have been collected. These efforts have been so well received that such data will be published annually. This section, during the past year, has assisted also in the handling of 500 claim adjustments involving amounts ranging from $35 to $75,000—after all other agencies had failed. Cooperation has been extended to American firms in the removal of trade difficulties arising from misunderstandings or differences in trade customs or requirements or from mistakes of fact. Through friendly representations, adjustments have been effected and good will for American trade has been maintained. Improper or questionable practices of foreign traders discovered through investigation of such difficulties are recorded for the protection of American firms. Where conditions have warranted, action has been taken with the cooperation of other Government departments looking toward the removal of underlying causes of the difficulties investigated.

The division consistently refuses to handle collections, but in many instances it has aided in such matters by furnishing practical advice

and the names of attorneys or collection agencies regarded as competent to represent American firms. Pertinent information is on file relative to more than 6,000 attorneys in 450 foreign cities.

FINANCE AND INVESTMENT DIVISION

The increasing usefulness of the bureau's finance and investment division is shown clearly in the mounting number and variety of the inquiries addressed to it by American bankers, underwriters, and investors. With the growth of the United States as a creditor Nation, each year has seen a greater number of new foreign issues underwritten and a rapidly rising proportion of the total foreign issues circulating here, about which prospective investors inquire. With the arrival in our market of more and more issues of foreign provinces and municipalities, the division has expanded greatly its material on their finances. Eventually the division expects to have as complete information in this wider field as it already has on the finances of central governments.

The addition of another research assistant to the division's staff has enabled it to compile more trustworthy statistics on current American investments abroad. These statistics are now issued to the press monthly and are published by the bureau quarterly. The statistics of seven previous years have been revised by painstaking research for a forthcoming publication on the underwriting activities of the United States since 1914.

During the year the division issued eight pamphlets on finances abroad and three more are nearly completed. The number of mimeographed circulars sent to the division's mailing list registered a great increase.

The statement of the international balance of payments of the United States for 1926 was refined by the inclusion of about 30 new groups of transactions totaling more than a billion dollars. The American "balance of payments" is now more complete than that of any foreign country. The questionnaire on the so-called unfunded items in our international trade elicited wholly new information on the importance of the United States as an international depository of short-term funds.

During some four months of the year the chief of this division was on a tour of investigation in Europe, where he served as an expert with the American delegation at the World Economic Conference at Geneva.

DIVISION OF FOREIGN TARIFFS

In addition to carrying out its long-established task of advising exporters as to foreign tariffs and trade regulations and assisting them in avoiding or overcoming difficulties, the division of foreign tariffs has made definite progress along several lines of work that give promise of great potential service.

As in previous years, a great many inquiries for information as to foreign rates of duty on specified products have been answered; the documentation required by foreign governments to accompany imports into their jurisdiction has been explained; pure-food laws,

commercial travelers' regulations, and related conditions of trading with foreign countries have been outlined—all in response to inquiries by telegram, by mail, and in person.

More detailed studies of specific problems have also been made—as, for instance, the advantages and disadvantages (from the tariff standpoint) to an American manufacturer in establishing an assembly plant in various parts of the British Empire, with data concerning the tariff treatment that would be accorded the resulting product, not only in countries of the British Empire itself but also in neighboring areas, such as the French colonies. Through studies such as these the manufacturer is able to get definite, reliable information on matters of vital significance to his plans.

The past year has also seen the successful solution of a number of other problems in which, with the cooperation of the Foreign Commerce Service, exporters have been extricated from difficulties and obstacles have been removed from the path of our foreign trade. The acceptance by a European country—without further certification—of the United States Federal inspection certificates covering certain meat products, thus avoiding additional routine and fees; the acceptance without change of an old-established label, with only an additional label showing the mark of origin, by a country well known for its stringency in regard to the "marking-of-origin" requirements; the acceptance by the administration of a large South American city of a particular type of scale manufactured in the United States, which had previously been objected to on purely technical grounds—these instances illustrate the type of problem in the solution of which the division's services have been of value.

An interesting instance of "preventive service" is to be found in the case of a shipment of catalogues which a firm was on the point of sending to customers in a country which levies such high duties on catalogues that the result would have been disproportionate expense to the recipients and consequent ill will toward the sender; a telegram from the division caused the shipment to be held up pending the receipt of a letter from the bureau explaining the disadvantages of this method and outlining a more satisfactory way of distributing the catalogues.

Special study has been made of particularly important subjects, such as tariff revisions pending and promulgated, to determine their effect upon our export trade. The question of certificates of origin as applied to indirect trade has been given careful consideration, as this problem is one of increasing importance to American exporters endeavoring to handle a number of small markets (particularly in Europe) more efficiently by establishing central warehouses in one or more large cities and distributing from these over the adjoining countries. If the enjoyment of the lowest tariff rates in the country of final destination is subject to the production of a certificate of origin made out in the country of original shipment, this constitutes a severe impediment to the practice just mentioned, since it is impossible to tell, at first shipment, to what country any part of the shipment will ultimately be destined. A satisfactory solution of this problem, to be incorporated in commercial treaties to be negotiated with the countries in question, will be of great value to American trade.

Cooperation with the Department of State in analyzing trade problems such as the above, arising in the course of commercial-treaty negotiations, has been continued as in former years. The material for a number of studies for the use of the American delegation to the World Economic Conference held at Geneva in May, 1927, was prepared in the division. The chief of the division attended this conference in the capacity of technical adviser to the American delegation. The tariff problems discussed at the Pan American Commercial Conference held in Washington during May, 1927, were closely followed, and the procedure resulting from the resolutions of that conference is being carefully studied.

Definite progress has been made during the year on the program of publications. Announcements of foreign tariff changes of interest to the American exporter have, as before, occupied several pages of each of the weekly issues of Commerce Reports, in which there have also appeared special articles discussing particular subjects in greater detail—such as the steel protection in British India and the new British merchandise marks act. During the year there was issued a trade-information bulletin entitled "Shipment of Samples and Advertising Matter to Asia, Africa, and the Insular Possessions"—the fourth in a series that covers all the countries of the world. A publication in which the export duties of the world have been compiled is in the hands of the printer and will soon appear. The manuscript for a handbook on Preparing Shipments to Latin American Countries is now ready for the printer.

Marked progress has also been made in the issuance of tariff manuals for specific industries. A 21-page study covering the Brazilian import duties on electrical equipment—listed according to both the Brazilian tariff and the United States export classification schedule—was prepared and issued. The foreign-tariff manual for the office-appliance industry was issued on September 1, 1926, and has been kept up to date by a quarterly correction service. A similar foreign-tariff manual on the leather-footwear industry is almost ready. A very important part of these two manuals is the correction service; there is compiled a mailing list of all those firms that have expressed the intention to keep the manual in active use, and every three months replacement sheets bearing corrections are sent to all addresses on this list.

A start has also been made in a direction that offers great scope for expansion and promises inestimable service. In the bureau's district offices the pressure of current work has always been such that prompt, complete checking of the basic tariff material on file in those offices has seldom been feasible. Accordingly, tariff inquiries have tended, in large proportion, to gravitate to Washington for reply. But with the expansion in number of the bureau's district offices in recent years, the possibility of giving prompt tariff service by telephone to exporters in all parts of the country now depends only on the providing of trained tariff experts in those offices equipped with extensive and clear basic files kept up to date by means of a simply operated "automatic" correction service from Washington. The bureau has made a beginning along this line. In several district offices the tariff service is now handled by men who have gone through a period of training in the division of foreign tariffs

at Washington. A start has already been made in the provision of the correction service for the district-office files. This new system is an experiment subject to improvement, but in view of the importance that tariff service assumes in the work of the district offices, its perfecting and expansion may be counted upon to be of great value to the American export trade.

DIVISION OF REGIONAL INFORMATION

The administration of the regional work at Washington was reorganized on July 1, 1926. In view of the generally similar types of service rendered by the former European, Far Eastern, and Latin American divisions, these were consolidated into one division called "division of regional information."

The division has followed economic events and tendencies abroad and prepared for publication its observations upon such factors as concerned American commercial and financial interests. Weekly trade cablegrams, monthly economic cablegrams, and special articles (based on reports of American commercial attachés and consular officers and research by members of the division) appeared during the year in Commerce Reports, and numerous special circulars and trade information bulletins were published.

The trade information bulletins consisted mainly of economic and commercial surveys of markets presenting opportunities for trade development but concerning which little had been published. These included Ethiopia, New Zealand, Sumatra, Hawaii, Portugal, Czechoslovakia, Switzerland, Ecuador, and Paraguay. Other bulletins issued were those entitled "Marketing in the Scandinavian Countries," "Business Practices in Greece," "Travel Routes in Caribbean Countries," and several pamphlets on sales territories in Far Eastern countries. Manuscripts of handbooks on the Anglo-Egyptian Sudan and on the Kingdom of the Serbs, Croats, and Slovenes were submitted to the editorial division for publication in the near future.

Nearly 100 mimeographed circulars were distributed to the mailing lists of the division. These included subjects such as "Chinese trade situation," "Conditions governing trade in Cuba," "Foreign trade of Greece," a series of circulars outlining a bibliography of Far Eastern countries, and a revised set of circulars on living costs and office-operating expenses in foreign countries.

Firms listed on the bureau's Exporters' Index received special trade data in the form of confidential mimeographed bulletins. These were confined, during the year under review, mainly to the Far East and Latin America, in view of critical conditions in those areas. A survey of economic developments in foreign countries was prepared each week expressly for the guidance of the district offices of the bureau in their contact with the business community. In the articles for Commerce Reports, particular attention was paid to subjects of current economic interest or descriptive material pertaining to promising markets for American products.

The division has practically completed the annual economic surveys of foreign countries for publication in the forthcoming Foreign Commerce Yearbook, which is to be the joint work of the division of statistical research and the division of regional information.

Contact has been maintained at all times with other Government departments, as well as with the American and foreign press. A survey of economic developments in the principal countries of Europe was prepared each month for the Department of Agriculture. Monthly cablegrams to the bureau's Far Eastern offices, outlining economic and commercial conditions in the United States, were disseminated through chambers of commerce and the Far Eastern press.

The chief of the division of regional information acted as liaison officer between the bureau and some of the other Government departments, particularly the Department of State. In May, 1927, the chief of the division visited Switzerland, to serve as one of the experts at the World Economic Conference held at Geneva.

Many direct business inquiries were handled throughout the year by the division of regional information. Market analyses and studies of individual export problems were made for a number of American manufacturers and exporters. For example, a chemical company was aided in determining the foreign sales possibilities for its products, a prominent mail-order house was advised with regard to the practicability of extending its activities into the foreign field, and a well-known financial organization was assisted in the compilation of an extensive chart of economic data.

STATISTICAL RESEARCH DIVISION

The work of the division of statistical research covers general investigation and compilation of data in the fields of economics, statistics, and geography, especially as related to industry and commerce. It compiles the Commerce Yearbook and the Statistical Abstract of the United States, prepares bulletins and articles analyzing trade and other statistics, and furnishes business men and other inquirers with information on subjects not falling within the scope of the more specific commodity, regional, and technical divisions.

The principal new activity of the division during the past fiscal year was in preparing for the publication of a separate foreign volume of the Commerce Yearbook. The yearbook has hitherto contained about 100 pages of statistical information on foreign countries. This is to be greatly expanded and, together with annual reviews of business conditions in such countries prepared by the regional division, is to be published as a separate volume. The preparation of the initial issue requires the compilation of a great mass of statistics for previous years, to be used for comparison with current data.

The division has continued the publication of bulletins analyzing the foreign trade of the United States by calendar and fiscal years, and summarizing the trade statistics of the principal countries of the world. It has also initiated, in Commerce Reports, a series of quarterly articles on the foreign trade of this country and a monthly summary of the trade statistics of the leading foreign countries. The division has continued to supply statistical data regarding the United States for standard statistical annuals and similar publications.

The work of this division's translation section during the year covered translations from nine languages, the greater part of these translations being of a highly difficult and technical character.

The geographic section of the division has further expanded its activities. The most significant new undertaking of the year was the

preparation, in connection with the Coast and Geodetic Survey, of a base map of the world on an equal-area base; this shows correctly the relative magnitude of the various countries, therein differing greatly from the widely used Mercator projection.

DIVISION OF STATISTICS

The division of statistics compiles and prepares for publication, monthly and annually, statements by countries and customs districts of imports and exports of merchandise, gold, and silver; of vessels entered and cleared; and other statistics of the trade of the United States with foreign countries and noncontiguous territories. The division issues regulations and instructions to collectors of customs regarding statistical reports; handles the correspondence and inquiries relating to United States foreign-trade statistics; and prepares the statistical tables published in the annual report on Foreign Commerce and Navigation of the United States and in the Monthly Summary of Foreign Commerce.

Foreign Commerce and Navigation for 1925 was issued in two volumes, and that practice will be followed for the 1926 report in order to expedite the issuance of the principal data for imports and exports.

The third annual report on the principal articles exported from each State was compiled for the calendar year 1926.

Weekly reports were published showing the exports of principal grains and flour; exports of pork products from principal ports; imports of raw wool into Boston, New York, and Philadelphia; and imports of wheat from Canada. The division issues monthly a special report on imports of cotton cloth, by specified trade designations, into five principal ports, and a similar report for imports of wool cloth.

About 15 monthly statements, showing the exports and imports of principal articles and groups of articles, are prepared from data compiled for the Monthly Summary and are published before the Summary is sent to the printer.

Special statements to the number of 253 are issued each month, showing exports and imports of principal articles by countries and customs districts, and are distributed in mimeographed form to thousands of paying subscribers. Beginning January 1, 1927, a charge of $1 per annum has been made for these statements. Naturally, this new system involving the payment of a small fee has resulted—for the time being, at least—in a smaller circulation of the special statements. The bureau feels encouraged, however, by the fact that 6,217 firms and individuals have considered the service so valuable that they have paid the $1 for the subscription; and it is confidently believed that this number will be substantially increased as the necessary adjustment to the new condition takes place.

TRANSPORTATION DIVISION

As typifying one phase of the transportation division's services, it may be stated that through the aid of this division an American car-manufacturing company was able to make a sale of $57,500 worth of cars to the Jamaica Government Railways.

A survey of some of the economic aspects of the proposed Great Lakes-St. Lawrence, Lakes-to-the-Hudson, and all-American waterways has been published during the past year by this division. This study includes estimates of the potential traffic available for movement by any of the proposed routes, the feasibility of lower freight rates to attract traffic from existing channels, the possibility of ocean-going vessels entering the Lakes trade via any of the proposed ship channels, and the economic benefits to be derived from the projects.

A set of standard contract terms and conditions for the warehouse industry—the result of cooperative work of the Bureau of Foreign and Domestic Commerce with warehousemen and other groups interested—was indorsed October 30, 1926, by the Department of Commerce, printed, and distributed. A survey of warehousing abroad has been inaugurated.

In collaboration with the United States Shipping Board the transportation division is conducting investigations and special studies of foreign ports, storage of ships' cargoes, storage factors, cargo handling, etc. A shipping-research section has been established in the division. The chief of the transportation division made a thorough personal study of European shipping and handling facilities and a thorough research pertaining to inland waterways of Europe.

A bulletin regarding ocean freight rates in United States foreign trade was issued last year. In Commerce Reports there were published semiannual surveys of economic conditions in the shipping and shipbuilding industries of the leading maritime countries. Advice was furnished American bankers interested in investment opportunities at foreign ports and American shipping men interested in the establishment or extension of steamship services. Cooperation was given in the adjustment of ocean freight rates, particularly on lighting glassware and toys to England, thereby helping to retain this trade against foreign competition. Work was begun on a handbook to cover the major free ports of Europe from the point of view of their relative advantages as centers of distribution for American goods.

Close contacts have been established and maintained with the regional advisory boards of the American Railway Association. Through the Florida division of the Southeastern Advisory Board and the Florida State Chamber of Commerce, the division completed an economic transportation survey of the State of Florida, which not only tended to prevent a repetition of the congested transportation situation of 1925 but also determined the situation regarding the principal commodity movements and general business conditions as related to transportation.

In both the domestic and export fields the packing section of the transportation division has continued its work of improving packing methods and minimizing loss and damage to merchandise in transportation. During the past year this section has brought to a successful conclusion important work in its domestic packing activities. Eight bulletins on scientific container construction have been published with the full approval of the advisory board on domestic packing. The first bulletin of this series, entitled "Paper Wrapped

Packages," has gained wide distribution, its sale having already reached 91,316 copies. The other bulletins of this series have recently been released, and preliminary sales indicate that the distribution of these will equal that of the initial pamphlet of the series.

The manual Packing for Foreign Markets has proved of great value to exporters. The marked improvement in American packing methods during the past few years is clearly shown by the fact that several European countries have sent delegations here to study our production and packing methods.

A handbook on the railways of South America, including all countries except Argentina (previously covered), Brazil, and Chile, was completed and distributed. Work has been initiated on the final South American railway handbook, which will discuss Brazil and Chile.

The bureau has recently appointed five trade commissioners and one assistant trade commissioner to specialize in automotive and transportation problems. Their posts will be at Paris, Stockholm, Buenos Aires, Wellington, and Calcutta. In addition, one man will be stationed in Buenos Aires to handle aviation transport problems throughout South America.

The highways section represented the department in arranging for the participation of the United States in the Fifth International Roads Congress held in Milan in September, 1926, and for the road tour of Latin American business men following the Pan American Commercial Conference in May, 1927. The section initiated a campaign to stimulate interest abroad in American methods of road construction and the use of American road machinery and materials—through the distribution of literature and motion-picture films obtained from leading trade organizations, trade publications, and the Department of Agriculture. Reports of road construction and development in foreign countries totaling more than $1,000,000,000 were brought to the attention of American companies through weekly circulars and Commerce Reports. Handbooks on roads in Australasia and India are under way.

The communications section originated a plan, approved by the aeronautics branch, for the employment of special trade commissioners to report on foreign aeronautics developments and to further the sales of American aircraft and equipment abroad. There was conceived and developed in the section the highly successful All-America Aircraft Display at Bolling Field, held during the Pan American Commercial Conference, the Pan American Aeronautics Conference, and the United States Chamber of Commerce convention.

The authentic map showing civil air services in Europe and other material prepared on aeronautics abroad have been so widely used that the section is recognized as the authoritative source of such information. Pertinent data have been collected for immediate dissemination, and details of all foreign air services are available. Two trade information bulletins on aeronautics in Europe and Latin America were under way at the end of the year, and material was collected for five others to be issued shortly. The bulletin entitled "International Communications and International Telegraph Convention" is being revised.

As indicated earlier in this report, improved handling of the bureau's own messages has resulted in further annual savings, amounting to nearly $5,000 in the monthly cable reviews alone. A code for the better and less expensive transmission of commercial intelligence is under way. A substantial part of the preparatory work of the International Radio Conference to be held at Washington in October, 1927, has been done and is in the hands of the communications section.

The assistant chief of the transportation division is acting secretary of the National Conference on Street and Highway Safety.

EDITORIAL DIVISION

The editorial division of the bureau, as in previous years, has edited a great number of reports, publishing them either in Commerce Reports, the department's illustrated weekly magazine, or in the form of monographs or trade information bulletins. During the fiscal year nearly 50,000 reports came to the bureau; most of these were recorded in the editorial division and directed to the appropriate experts for their consideration. On the basis of such data, the division published more than 16,000 printed pages of information designed to benefit American trade, industry, and finance.

STANDARDIZATION WORK

Acting (as is its uniform practice) in close cooperation with the Bureau of Standards, our section on Pan American standards developed the organization (through appropriate trade committees) for the Second Pan American Standardization Conference held in May, 1927. Definite steps were taken to insure at an early date the establishment by international committees of some commodity standards acceptable in inter-American trade.

This section of the bureau endeavors to further in all practicable ways the adoption of standards in commerce. Spanish translations of 17 standards for electrical machinery, equipment, and apparatus were published and distributed during the past year, a committee of the American Institute of Electrical Engineers having prepared the translations. Manuscripts for a Portuguese-language series of industrial standards were completed and will be printed and distributed early in the next fiscal year.

The use of specifications in foreign trade is growing. Exporting manufacturers of the products covered by the issues of the Spanish series of industrial standards, released late last year and early this fiscal year, encourage the bureau to continue with this work on a broader scale.

The bureau continued its support of standardization, simplification, and elimination of waste in commerce and industry, lending its aid to the Bureau of Standards, Federal Specifications Board, Division of Simplified Practice, other governmental agencies, and private organizations in this work. While its activities along this line are mainly cooperative, it has taken the initiative in simplifying statistical data, in standardizing terms and forms, and in encouraging sim-

plification and the elimination of waste in domestic and foreign distribution of merchandise.

For some years the bureau's field men and the consular officers have collected information and prepared reports concerning important national and international fairs and expositions overseas, as in many countries these exhibitions afford an excellent opportunity for increasing sales of merchandise. American manufacturing exporters and export merchants are now taking a greater interest in the more important of these affairs and in larger numbers are calling for service in connection with their proposed or actual participation.

COMPARATIVE STATEMENT OF SERVICES RENDERED

In the following tables are figures presenting a concise picture of the development, during the past five fiscal years, in the more important phases of the bureau's activity:

Items	Fiscal year ended June 30—				
	1923	1924	1925	1926	1927
Commercial services rendered:					
Total services rendered	[1] 881,521	[1] 1,168,972	[1] 2,041,250	[1] 1,973,524	[1] 2,421,563
Commodity—					
Agricultural implements	14,014	28,353	47,841	29,753	53,444
Automotive	56,232	105,459	181,606	228,727	214,806
Chemical	36,984	66,601	105,477	119,613	122,300
Coal	5,356	6,711	8,744	4,199	4,788
Electrical	32,636	64,355	112,245	133,462	109,947
Foodstuffs	103,373	143,579	142,306	155,301	180,867
Iron and steel	27,918	52,288	112,559	221,252	213,949
Leather	12,881	23,471	29,108	16,858	26,300
Lumber	26,177	37,826	70,483	91,393	118,472
Machinery	46,399	71,999	99,038	117,200	90,937
Minerals	[2] 18,566	[2] 21,371	[2] 45,049	[2] 23,973	[2] 49,715
Paper	13,668	16,923	17,518	11,785	21,861
Rubber	14,407	19,894	21,208	14,260	21,790
Shoes	10,211	11,892	10,388	7,148	12,744
Specialties	75,023	97,860	230,223	185,667	134,637
Textiles	64,429	80,669	106,195	106,590	124,332
Technical—					
Commercial law	10,376	14,727	14,543	16,318	16,984
Finance and investment	7,660	13,726	15,546	20,578	27,743
Statistics (foreign trade)	23,530	28,711	29,871	50,749	37,874
Transportation	15,193	20,940	28,620	25,806	36,506
Tariffs (foreign)	19,764	25,730	27,062	30,031	43,160
Domestic commerce	----------	19,148	51,370	65,559	61,786
Miscellaneous	246,724	215,887	585,620	362,861	758,407
Regional and reclassification of above—					
Latin America	132,486	232,200	329,737	288,649	576,292
Near East	29,287	49,917	52,464	42,718	99,758
Far East [4]	93,224	173,763	253,875	246,990	288,631
Eastern Europe	29,812	55,617	53,295	40,390	94,165
Western Europe [5]	269,244	339,679	745,318	831,043	718,324
Foreign trade opportunities:					
Number of individual opportunities published	4,290	3,846	4,909	5,380	5,088
Number of cases in which reserved information was furnished	332,127	345,784	446,865	437,059	578,343
Trade lists (lists of foreign merchants) ----------number of copies	181,049	417,195	687,159	578,524	537,144
Special informational circulars (mimeographed)----------number of copies	1,000,000	3,100,000	3,713,800	3,327,120	2,583,725

[1] Does not include services rendered by the foreign service of the bureau and by the cooperative offices maintained by the bureau in chambers of commerce and boards of trade in the United States.
[2] Petroleum only.
[3] Includes petroleum.
[4] In the bureau's organization, this includes Australia and New Zealand.
[5] Includes Africa and Canada (possessions, "mandated" territories, and Dominions politically related to western Europe).

RECOMMENDATIONS

1. Larger appropriations are needed to meet the rapidly increasing demands for the expansion of the bureau's services in the field of eliminating wasteful methods in domestic commerce. The urgent necessity for this has been indicated rather fully in the opening pages of this report. (See pp. 73 and 74.) Along this line lies the possibility for the greatest development of our activity during the next few years, and it is here that the bureau organization can do work most productive of profit and savings for American consumers, producers, and distributors.

2. Trade organizations are insisting that 10 new foreign offices be established by the bureau as soon as possible in regions not now covered by Department of Commerce men. There is a strong conviction that offices in Budapest, Lisbon, Winnipeg, Rangoon, La Paz, Guatemala City, Port au Prince, Algiers, Durban, and on the west coast of Africa would prove a good investment for the business interests of the United States. Competition from Europe is becoming much keener everywhere, and from this source American trade is more or less endangered in many regions and in many ways. To maintain themselves in oversea markets our manufacturers need—in the territories indicated above—such expert assistance and dependable data as the Foreign Commerce Service furnishes.

It seems appropriate, at this point, to express the bureau's clear recognition and cordial appreciation of the services rendered by the members of the Consular Service of the State Department, who, working harmoniously with the Foreign Commerce Service, have submitted much valuable commercial information. The two services will continue, as in the past, to supplement and relieve one another and to avoid duplication of effort in accordance with the Executive Order of April 4, 1924.

3. In addition, the interested trades feel that 10 new trade commissioners should be appointed on the bureau's foreign staff for specialized commodity service—each to devote his attention to the promotion of trade in a particular line. Each trade commissioner of this character would study a rather broad territory, following conditions and tendencies throughout that entire field. As indicated on page 91, the work already accomplished by such commodity trade commissioners now in the service has proved of great advantage to American trade and has been received with a high degree of satisfaction by the interests directly benefited, which have included (among others) automotive products, lumber, motion pictures, grain, meats, and dried fruits and nuts. New trade commissioners of this kind are needed to cover the following subjects, in the indicated regions: Agricultural implements, in South America; chemicals, in the Far East; electrical equipment, in Europe; leather, in the Far East; lumber, in Australia and New Zealand (or in South Africa); machinery, from London; paper, in Europe; shoes, in the Caribbean area; textiles, in Australia (or in South Africa or India); automobiles, in Europe. Only by the employment of such men can we combat effectively the growing competition of foreign manufacturers in these lines and enable our own producers to retain and enlarge their place in world markets.

4. The practical way in which the business men of the respective local communities have responded to the bureau's opening of new district offices in the United States during the past year shows that this service is fully justifying itself and deserves to be further extended by the establishment of district offices in Indianapolis, Raleigh, Birmingham, Cleveland, Cincinnati, Omaha, Denver, El Paso, Savannah, Charleston, and Pittsburgh. At a number of the existing offices it seems highly desirable to install statistical clerks and (at five of the principal offices) shippers' regional advisory board experts—men thoroughly familiar with the transportation situation, to work in close cooperation with the regional boards for the purpose of facilitating merchandise movements.

If sanctioned by the Congress, the measures just mentioned will round out, in large degree, a service which is shown, by the facts cited in the preceding pages, to have been one of substantial benefit during the past year to the American people as a whole.

Very truly yours,

JULIUS KLEIN, *Director.*

BUREAU OF STANDARDS

DEPARTMENT OF COMMERCE,
BUREAU OF STANDARDS,
Washington, July 1, 1927.

Hon. HERBERT HOOVER,
Secretary of Commerce.

DEAR MR. SECRETARY: I submit herewith a brief report upon the work of the Bureau of Standards during the fiscal year ended June 30, 1927. The various outstanding accomplishments are grouped according to the subjects for which Congress had made specific appropriations.

GENERAL ACTIVITIES

Organization.—During the past year the assistant director has acted as liaison officer on matters of aviation between the Aeronautics Branch of the Department of Commerce and the Bureau of Standards. Work formerly conducted by the Bureau of Mines transferred to the Bureau of Standards on July 1, 1926, and some of the work on lubricants formerly carried on by the automotive power plants staff have been consolidated to form a new section on friction and lubrication in the heat and power division. Several resignations caused by the bureau's inability to meet the salaries offered by industry made necessary reallocation of the work in several sections.

Cooperation.—Most of the bureau's work is made effective through voluntary cooperation of the State and municipal governments, scientific and professional societies, trade associations, manufacturers, and individuals who accept the findings of the bureau and incorporate them into a State law, a municipal ordinance, a dimensional standard, or a standard of quality, performance, or practice.

All such cooperation is encouraged to promote a better understanding between producer and consumer and between industries, to the end that industries shall be, so far as practicable, self-regulatory.

Many national organizations assist the bureau directly in research, standardization, and simplification, and in turn the bureau cooperates with numerous national organizations engaged in similar effort, frequently designating members of the staff to serve on committees.

The extent of these relationships is shown by the fact that at the present time the bureau is cooperating with over 200 scientific, technical, and industrial organizations. In many cases the work with any one group covers a single project, while in other cases 25 projects or more are being handled by practically every division of the bureau.

One of the most effective ways in which the bureau cooperates with American industries is through its research associate plan, referred to in past annual reports. At the close of the fiscal year there were 63 of these associates stationed at the bureau, representing 38 industries and associations.

Personnel matters.—The regular staff at the close of the fiscal year numbered 850 employees. In addition there were 63 employees assigned to the bureau under the research associate plan and 11 miscellaneous assignments, including guests and details from other branches of the Government, making a grand total of 924 persons.

The turnover was 24.2 per cent, and although there were 449 promotions the average salary ($2,210) decreased by $22.

The status of the personnel shows an increase of 87 employees as compared with last year. However, 52 of these were added as the result of reallocation of work within the Government service. The employees engaged in operating the mechanical plant were transferred back to the bureau's rolls, and the ceramic laboratory at Columbus, Ohio, and the oil-testing work were transferred from the Bureau of Mines.

Visiting committee.—This committee, established by law "to visit the bureau at least once a year and report to the Secretary of Commerce upon the efficiency of its scientific work and the condition of its equipment," met at the bureau twice during the past year and has given particular attention to the financial needs of the bureau to meet the ever-increasing demands from the public and Government for testing and research, as embraced in two reports to the Secretary of Commerce. The present personnel of the committee is S. W. Stratton, Gano Dunn, William F. Durand, W. R. Whitney, and John R. Freeman.

International relations.—The usual close cooperation between the national standardizing laboratories of other countries and the Bureau of Standards has been maintained. Negotiations have been carried on for the improvement of standards on which electrical, photometric, and radio measurements depend. The International Committee on Weights and Measures has proposed a chain of comparative measurements, including the national laboratories of Germany, France, Great Britain, Japan, and the United States, and the bureau has prepared standards of voltage and resistance for shipment to Japan and Great Britain. Standards of candlepower representing the newer types of lamps have also been prepared for exchange with the national laboratories in Europe. Comparisons of radio-frequency have been made with several of these and other laboratories by means of quartz piezooscillators which have been shipped from one laboratory to another.

In September the International Conference on Weights and Measures will meet in Paris. This conference meets at least once in six years, and outstanding problems in metrology are discussed. The bureau expects to present several important questions for consideration in the fields of metrology, optics, and electricity.

The second Pan American standardization conference was held in Washington on May 9 to 11. The last day's session took place at the Bureau of Standards, and a beginning was made in the grading of commodities of Latin-American origin.

Weights and measures conference.—The Twentieth National Conference on Weights and Measures was held on May 24 to 27 and was attended by 225 persons, of whom 102 were official representatives from 22 States, Porto Rico, and the District of Columbia.

Among the important constructive actions taken by the conference may be mentioned the adoption of a code of specifications and tolerances for bottles for the sale of lubricating oil, modification of specifications for liquid measuring devices, completion of important preliminary work on specifications and tolerances for grease-dispensing devices, adoption of recommendation for sale of ice cream on volume basis with regulation of "overrun," and adoption of amendments to model State weights and measures laws establishing ton of 2,000 pounds for all commodities and cord of 128 cubic feet for measurement of firewood.

State utility commission engineers' conference.—The fifth annual conference of State utility commission engineers was held at the bureau June 2 and 3 and was attended by representatives of 16 State commissions and one Province of Canada. The program included discussion of street railway, electric, and gas service, as well as problems in the determination of depreciation and the theory of rate schedules.

American Engineering Standards Committee.—Cooperation has been continued with the American Engineering Standards Committee. The bureau is sponsor for 13 standardization projects and is represented on 73 committees having for their object the formulation of "American standards."

National Screw Thread Commission.—The standards established by the National Screw Thread Commission provide for two series of threads, a coarse and a fine, and for four classes of fit, ranging from the loose fit for very rough work to the close fit for work of the highest precision. Dimensions and tolerances for each thread series and class of fit are included in a report issued in 1924. Specifications and tolerances for pipe threads, fire-hose threads, and small-hose threads are also included.

Certain details of the 1924 report have been perfected, and several new sections on special threads have been added. The commission has also cooperated with the standardization committee of the American Petroleum Institute in the standardization of drilling-tool joints, pumping equipment and gauges, and with the Federal Specifications Board in the standardization of machine screws, bolts, and nuts to be purchased by the Federal Government.

Much time and attention are now being given to the important task of specifying dimensions of threading tools and limit gauges which will insure that a product within these limits will result when the tools are properly used under normal working conditions. This work is in cooperation with large manufacturers and users of threading tools.

Federal Specifications Board.—The board has been in existence for nearly six years and has just promulgated the five hundredth purchase specification. The use of these specifications is mandatory on all Government activities by Executive order. These specifications are being used more and more by State and municipal governments, institutional bodies, and by industry. Much of the research and experimental work necessary in connection with the formulation of the Federal Specifications Board specifications is done by the Bureau of Standards.

66698—27†——9

Facilitating the use of specifications.—The inability of most purchasers to test goods which they buy has prevented a more widespread use of specifications. The "certification plan" has been introduced to eliminate this disadvantage.

Lists have been compiled of manufacturers who will certify to purchasers that goods delivered comply with certain specifications. These lists will be forwarded upon request; 75 commodities have been covered to date.

A list of commercial and college laboratories which will make tests to determine whether deliveries comply with specifications has been published.

Relations to Government departments.—The bureau is authorized to receive funds for specific research projects from other departments, and in pursuance of this policy in the past year the bureau has received $295,000 for the support of 44 projects representing work for nine Government establishments. In addition, the bureau does a great deal of consulting, specification, and testing work for various branches of the Government.

Publicity.—In addition to its regular official publications, of which 118 were issued during 1927, the monthly Technical News Bulletin has been mailed as heretofore. The number of pages has been increased, and this bulletin is on a self-supporting basis. More than 200 papers have been published in outside technical journals. There have also been released to the press about 250 short accounts of interesting achievements, together with many photographs illustrating the bureau's work. These news items serve as nontechnical progress reports on the activities of the bureau to the taxpayers of the country.

There was also issued the first annual number of the Standards Yearbook, giving a summary of standardization activities in the United States for the past year.

Tests completed.—An itemized statement of tests completed is given in the following table:

Numbers of test items, determinations, and fee value for tests completed during the fiscal year ended June 30, 1927

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	1,247	497	22	1,964	3,927	$13,732.89
Electric batteries		1,537		1,537	2,944	9,769.50
Electric lamps and lighting equipment	201	2,691	451	[1] 3,343	3,541	[2] 17,564.12
Length-measuring devices	172	168	2	342	2,113	2,063.90
Gauges and gauge steels	1,540	479	1,055	3,074	11,854	2,478.00
Miscellaneous dimensional determinations	2,118	1,361	87	3,566	14,052	6,411.90
Weights and balances	5,942	1,143	533	7,618	16,201	4,893.40
Scales		979		979	25,352	42,990.00
Timepieces	427	10	18	455	5,871	912.00

[1] In addition the bureau inspected 1,216,751 incandescent lamps at various factories for other branches of the Government.

[2] Includes fee value of $3,196.12 for lamps inspected at factories.

Numbers of test items, determinations, and fee value for tests completed during the fiscal year ended June 30, 1927—Continued

Kind of instrument or material, class of test, or nature of service rendered	Number of test items for—			Total number of test items	Number of determinations	Fee value
	Public	Government departments and State institutions	Bureau of Standards			
Volumetric apparatus	6,932	4,949	154	12,035	23,046	$7,657.00
Hydrometers	627	128	5	760	2,327	1,149.45
Density determinations, etc	59	7	294	360	560	536.00
Laboratory thermometers	2,161	825	235	3,221	17,447	6,309.55
Clinical thermometers	34,950	28,819	----------	63,769	255,076	5,043.41
Pyrometers, calorimeters, etc	167	60	124	351	3,289	3,703.74
Insulating materials	32	37	16	85	141	620.00
Fire-resisting materials	17	44	----------	61	145	4,863.00
Fuels and lubricants	60	1,693	160	1,913	12,295	18,530.00
Automotive equipment, etc	175	67	24	266	903	1,136.50
Optical instruments and materials	319	506	195	1,020	2,542	5,095.60
Carbohydrates	17	1,897	----------	1,914	2,906	3,194.50
Radioactive materials	523	31	----------	554	564	3,493.00
Engineering instruments and appliances	128	640	54	822	956	10,758.50
Aeronautic instruments	21	229	14	264	750	3,686.00
Aerodynamic tests of models	12	5	10	27	96	1,452.00
Physical properties of engineering materials	373	2,292	144	2,809	5,103	15,517.17
Sound producing and measuring instruments	15	51	27	93	117	1,398.50
Making of special castings	----------	58	262	320	989	2,613.68
Fusible boiler plugs	----------	366	----------	366	731	1,827.50
Metallographic examinations	----------	381	99	480	682	2,373.36
Miscellaneous metallurgical tests	----------	377	615	992	2,823	6,460.82
Pottery and chinaware	5	212	10	227	780	1,523.00
Glass	----------	22	18	40	120	455.00
Refractories and heavy clay products	4	62	81	147	1,076	2,860.00
Cement, concreting materials, lime, etc	36	8,394	125	8,555	28,435	112,838.33
Stone and sand-lime brick	----------	48	4	52	732	369.25
Miscellaneous ceramic materials	3	1,634	87	1,724	2,159	8,254.50
Rubber	----------	1,521	376	1,897	12,160	28,218.26
Textiles	----------	6,298	211	6,509	14,182	24,362.00
Paper	47	2,036	160	2,243	6,565	16,008.00
Leather	13	218	1	232	1,028	1,627.00
Paint, varnish, and bituminous materials	----------	1,170	19	1,189	9,687	21,030.79
Chemical analysis of metals	1	465	354	820	3,526	11,982.80
Chemical tests of miscellaneous materials	----------	999	108	1,107	3,909	9,965.60
Distribution of standard samples	5,830	630	20	6,480	24	13,545.50
Total	64,174	76,036	6,372	146,582	[1] 503,726	[1] 461,265.02

[1] Of these totals, 214,826 determinations were for the public, fee value, $60,228.73; 269,367 determinations were for the Government departments and State institutions, fee value, $357,874.64; 19,533 determinations were for the bureau, fee value, $43,161.65. 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, are not included in these totals.

SALARIES ($567,320)

This fund provides for personal services of administration and operation; the establishment, upkeep, and comparison of standards; the development of methods of test, as well as most of the testing; and for the determination of fundamental constants of importance in physics, chemistry, engineering, and technology not otherwise provided for.

Basic electrical units and standards.—Progress has been made in checking the commonly used values of the electrical units by reference to the fundamental definitions. The need for this work has become more urgent because the International Committee on Weights and Measures is now taking up the problem of establishing and

maintaining authoritative international values for the units. Coils and related apparatus must be constructed with a very high degree of mechanical precision in such form that their electrical properties can be calculated and these calculated values compared with those found by electrical measurements. One part of this work on the induction of a helix made with wire of any section has been published, and another paper on absolute measurements of capacitance by Maxwell's method is in press.

Constant of gravitation.—After four years of work with improved apparatus the first results of the redetermination of the Newtonian constant of gravitation were obtained during the past year. Five values have been obtained—6.661, 6.661, 6.667, 6.667, and 6.664—giving as a mean 6.664 by 10^{-8} cm. ^{3}/gm. sec.^{2}, a result ten times more accurate than hitherto obtained.

Standard of planeness.—Three standards of planeness have been made of clear fused quartz, a material chosen because its distortion arising from temperature irregularities is about one-fifteenth that of glass. They are in the form of disks about 10 inches in diameter and 1½ inches thick, being rigid enough to rest on three points without appreciable distortion. The workmanship on these flats is of such a high grade that all three surfaces depart from planeness by less than one-hundredth of a light wave length—less than two ten-millionths of an inch.

Airplane lenses.—In order to select the best lenses to be used in aerial mapping complete tests were made on 74 lenses for the Army Air Service. Special attention was paid to the determination of the amount of distortion present in the photograph.

High precision method of lens testing.—The well-known Hartmann test has been modified to permit the interpretation of the aberrations of the lens, in terms of wave length, by means of the diffraction effects of the apertures of the Hartmann diaphragm. This method, which readily determines quantitatively even the effect of striæ, differs from other interferometric methods in that it can be applied to large telescopes without the necessity of having large auxiliary optical flats.

Filters for photographic sensitometry, colorimetry, and photometry.—A series of liquid filters, reproducible from specification, has been developed for converting to average noon sunlight the energy distribution of incandescent lamps having any "color temperature" between 2,300° and 4,000° absolute. Important by-products of this investigation are (*a*) the application of these same filters to the measurement of color temperature and intensity of incandescent lamps and (*b*) the development of a similar group of filters for converting the color of a lamp operated at 2,848° (the bureau's standard) to any color temperature between 3,000° and 10,000° absolute.

Therapeutic light sources.—An investigation of the radiation from the carbon arc under different conditions of operation was conducted in cooperation with the National Carbon Co. Data were obtained on the ultra-violet component of the radiation using different kinds and sizes of carbon electrodes, different kinds of cores for these, large and small electric currents; also with direct current and alternating current potentials.

Windows for transmitting the "vitalizing" rays of sunlight.—After investigating the ultra-violet transmission characteristics of numerous substitutes for window glass it was found that the most widely known of the new glasses transmits about 50 per cent of the vitalizing rays of sunlight which are excluded by ordinary window glass, and a more recent production shows about 92 per cent transmission. Glass substitutes, consisting of a cellulose product on wire mesh, fall somewhat below 50 per cent.

Revision of solar spectrum wave lengths.—In cooperation with the Allegheny Observatory wave lengths of 400 lines in the yellow, orange, and red portions of the spectrum have been measured and published. Comparison of these solar values with laboratory values shows a red displacement of the solar lines as a function of their intensity but in which the displacement appears to be somewhat smaller for the longer than for the shorter wave lengths. If it is assumed that the intensity scale for the longer waves is the same as for the shorter, these results continue in contradiction to the explanation given by the Einstein gravitation theory.

Density of pure iron and carbon steels.—The densities of pure iron and of various carbon steels have been determined. The average density of pure iron is 7.864 grams per cubic centimeter. Carbon steels as hot-rolled show a gradual decrease in density with increasing carbon content up to about 1.3 per cent and lie on or close to the straight line:

$$\text{Density} = 7.855 - .032\ C$$

where C is the percentage of carbon.

Carbon steels as annealed show a gradual decrease in density with increasing carbon content up to about 1.4 per cent, and the values lie on or close to the straight line:

$$\text{Density} = 7.860 - .04\ C$$

where C is the percentage of carbon.

The density of carbon steels containing up to about 1.3 per cent carbon decreases upon quenching, due to the formation of martensite. The magnitude of this decrease rises with increasing carbon content, reaching a maximum at about 1 per cent carbon and then falls off slightly. Upon tempering the quenched steels they gradually increase in density. A decrease in density was noted in the hypereutectoid steels, when tempered at 225° C., due to the tempering of retained austenite. Upon tempering about 225° C. the density of all samples increased, ultimately approaching the density of the annealed material when tempered at 600° C. The greatest rate of increase of density was noted upon tempering at 300° C., the rate then gradually falling off practically to zero at 600° C.

Properties of pure metals.—The fundamental properties of pure thorium and pure nickel have been investigated, so that the bureau is prepared to give information on the constants of these important metals. The melting of nickel of purity hitherto unreached, by methods which avoid contamination, and the working of it into form suitable for determining its constants have been successfully accomplished. Special refractories have been prepared for melting the pure metals. Methods for obtaining precision measurements of the

lattice constants of thorium by the X-ray spectrograph have also been developed. The metallographic properties of pure iron have been studied in cooperation with a research fellow of the Swedish-American Foundation.

Metallurgical testing, research, and service for the Government.—Testing of metals and allied materials for other branches of the Government included routine tests of 341 fusible plugs for the Steamboat Inspection Service and research on factors affecting their possible failure to function in service; examination of failed propellers for the Bureau of Aeronautics of the Navy; tests of iron pipe for the repair of the White House; study of air-hardening rivets for armored tanks, at the request of the Ordnance Department of the Army; testing of foundry sands for the Panama Canal and the Washington Navy Yard; and a wide range of miscellaneous tests. Advice has been given the Department of Justice and the Federal Trade Commission on metallic products. Work on tarnish-resisting silver alloys for the Bureau of Mines has been completed and published. Metallurgical work has been done on storage-battery alloys for the Navy.

Wear of metals.—The fundamental properties of metals used for gauges affect their resistance to wear. Special apparatus has been constructed to study the wear resistance of gauges in the laboratory. Chromium-plated gauges and special steel gauges given a nitride coating by treatment in ammonia have been found markedly superior to ordinary gauges in resisting wear. This phase of the wear problem is completed, one report has been issued, and a second is ready for publication.

Elastic hysteresis research.—A technologic paper on the statical hysteresis in the flexure of bars was issued, in which a new fundamental constant has been shown to exist, called the statical hysteresis modulus. Experiments on the statical hysteresis in cycles of equal load range have greatly widened the applicability of the law given in the above paper. A theoretical relation has been deduced between the damping of a tuning fork in air and the statical hysteresis modulus of the material of which the tuning fork is made.

Magnetic testing methods.—A new edition of the circular on magnetic testing has been issued and special studies of commercial testing methods have been reported in a paper on determination of the magnetic induction in sheet steel. The applicability of magnetic measurements as an indication of mechanical properties of materials has been treated in papers on nondestructive testing of wire hoisting rope by magnetic analysis and on the magnetic reluctivity relationship.

Standards of candlepower.—The bureau several years ago established provisional standard values for the newer types of electric lamps, but no international agreement has yet been reached on candlepower standards of these types or on a general method of making photometric measurements when the lights to be measured differ in color. Comparisons have been made both with laboratories in this country and with national laboratories abroad. When completed, these comparisons will serve to determine the constancy with which the basic carbon standards have been maintained in the different countries and will indicate the degree of agreement attainable in the establishment of the newer standards by the various methods available.

Lamp-testing methods.—The general introduction of the new types of inside-frosted electric lamps has required changes in testing procedure. The specifications for lamps have been revised and the testing methods used have been published.

Time of breakdown of paint.—Progress was made on a quantitative method of determining the time of breakdown of paint and similar coatings, as well as a study of accelerated tests to simulate weather decay.

Changes in rubber compounds.—An investigation of the effect of added fatty acids upon the tensile properties of rubber compounds was completed, and progress was made on a study of the changes caused in rubber by heat, light, and oxidation, and the effect of adding antioxidants.

Impurities in reagents.—The bureau's critical study of methods for detecting and determining small amounts of impurities in reagent chemicals was continued. This work formed an important contribution to the specifications for a number of chemicals prepared by the American Chemical Society.

Increasing speed of zinc plating.—A study of acid zinc-plating baths showed that by appropriate additions the conductivity and permissible rate of deposition can be greatly increased.

Apparatus for analyzing breath.—A thermal conductivity apparatus for determining both carbon dioxide and oxygen in respired air has been developed. Because of the rapidity with which determinations can be made, physicians are very enthusiastic about the method and anticipate its extensive adoption in hospital practice.

Weights and measures.—This work included investigations of steel tapes to determine thermal expansion and of Young's modulus and sag correction; a study of watches equipped with invar balances and elinvar hairsprings; the effect of humidity changes on the constancy of lacquered analytical weights; density changes in glass and in steel caused by changes in heat treatment; the application of the photo-electric cell to the measurement of short-time intervals; the thermal expansion of creosote oils; the density of copper; and the density and weight per gallon of denatured alcohol.

Variability in weights caused by changes in atmospheric humidity.—A study of variations in gold-plated and lacquered screw-knob weights under relative humidities of 30 and 70 per cent shows that (1) changes in the weights are sometimes of great importance—occasionally as large as 2 or 3 mg. on the sum of the weights in sets from 1 to 50 or 100 g.; (2) in general, gold-plated weights showed greater variability than lacquered weights, apparently because the plating salts from the electroplating solution had not been wholly removed from the cavity under the knob. These weights can be improved by thoroughly washing out these salts, and manufacturers who have adopted this precaution are now furnishing much more stable weights.

Orifice-meter investigation.—The particular object of this year's cooperative work with the Natural Gas Association has been a study of the effects of various combinations of bends, regulators, valves, and straightening veins upon the indications of orifice meters. Very consistent and instructive results were obtained, which showed some previous ideas on orifice-meter behavior to be erroneous.

Viscosity and consistency measurement.—A diagram has been devised for estimating the viscosity of petroleum oils at one temperature when known at another. For some materials, such as oils containing soap, the usual methods of measuring viscosity do not apply. A new type of apparatus suited for this purpose, known as the "burette consistometer," has been investigated and found to be both accurate and rapid in operation.

Thermal properties of petroleum products.—A thorough review of the literature and of data obtained at the bureau indicates that certain properties of petroleum products—namely, coefficient of expansion, heat of combustion, specific heat, latent heat of vaporization, and perhaps thermal conductivity—can be calculated within close limits if the density of the oil is known, as set forth in a paper before the American Chemical Society.

Platinum resistance thermometry.—An investigation of platinum-resistance thermometers has been undertaken to aid in the standardization of a low-temperature platinum resistance scale of temperatures to −183° C. as a part of a cooperative program between the bureau and the national laboratories of England, France, Germany, and the Netherlands for uniformity in temperature measurements.

Specification for automobile tires.—The Government purchases of tire equipment amount to approximately $1,500,000 a year, with a rapidly increasing proportion of balloon and truck tires. As a result of tire tests during the past three years the bureau, with the cooperation of the Rubber Association of America, has obtained sufficient data to revise the Federal specification for automobile tires, so as to include balloon tires and truck tires. In this specification an endurance test simulating road service has been provided for each size and type of tire.

Construction of apparatus for laboratory and other purposes.—The instrument shops, machine shops, pattern and woodworking shops, glass-blowing shop, tool room, and construction storeroom took care of all demands made upon them for the construction of instruments, apparatus, and their installation in the laboratories, as well as the preparation of all routine samples submitted for tests and the preparation of the standard steel, cast iron, and various alloy steels used as standard samples.

Some of the more important instruments and apparatus constructed during the year are: Diffuse reflectometer, optical lens centering apparatus, 10 small laboratory telescopes, interferometer, pendulum apparatus, furnace for expansivity testing, sand-blasting machine for the numbering of clinical thermometers, proving rings for calibration of testing machine, ionization chamber, graduated track for Weber photometer, three radiobeacon goniometers, magnetic comparator for fatigue machine, spherometer, vibration galvanometer, commutator and switch for platinum-resistance thermometer bridge, camera for spherical aberration tests, radiobeacon interlocking switch, installation of grating mounting in constant-temperature room of spectroscopic laboratory, electric furnace, wear-test machine, alpha ray counting apparatus for exhibit at New York Industrial Museum, galvanometer for Maxwell bridge, variable mutual inductance apparatus, two 500-microhenry self-inductances, one telescope for absolute electrometer, one 10 and one 20 inch strain gauge, one

resistance box (0.01 ohm and 10,000 ohms), one resistance box (100 to 10,000 ohms), one rotating sample holder, X-ray tube holder, and hardness testing apparatus.

Operation and maintenance of buildings.—The employees engaged in plant operation and maintenance are divided into three principal groups—namely, power plant, guard, and janitorial groups. The first group operates and maintains the power plant which supplies heat, light, power, and other miscellaneous service; the second group polices the bureau's property; and the third group does the routine cleaning work within the buildings. The functions were performed as usual.

EQUIPMENT ($88,000)

General equipment.—The usual purchases of apparatus and supplies necessary to maintain the bureau's laboratories in up-to-date and efficient condition have been made. A considerable amount of special equipment for the radio section has been purchased for use in connection with experiments on radiobeacons and radio transmission between planes and the ground.

Supercalender stack.—A new supercalender stack was purchased for the experimental paper mill. This machine is fitted for five rolls, 27 inches wide, and is driven by a variable-speed electric motor giving roll speeds of 40 to 300 feet per minute.

Dead weight testing machine.—A dead weight vertical testing machine of 100,000 pounds capacity, built by A. H. Emery, jr., in accordance with suggestions made by the bureau, has been secured. It will be used primarily in the accurate calibration of proving rings, which in turn will be used for the calibration of service testing machines in the field. The 10,000-pound weights are applied to the ring with the aid of a hydraulic press so that the load may be applied either in tension or in compression in 10,000-pound increments up to a maximum of 100,000 pounds.

New constant-temperature room.—The new equipment for graduating and testing circles and for comparing linear scales will be installed in a new basement room which has just been completed.

GENERAL EXPENSES ($68,355)

Upkeep of mechanical plant.—The usual maintenance work and repairs have been carried on. A 25-ton refrigerating plant was installed in the industrial building. New commutators were mounted on fan motors for the bureau's heating system.

Electrical construction and repairs.—The work included the usual maintenance and construction, as well as some extensions to the electrical service carrying various voltages. Several large pieces of equipment were connected up, such as the new supercalender in the paper section, large electromagnet in the new spectroscopic laboratory, 100-horsepower rotary exhausters in the altitude laboratory, and a 200-horsepower motor for a large air compressor.

Plumbing and steamfitting.—Work required by several extensions of gas, air, vacuum, water, steam, and refrigeration lines was performed. Special installations included a large air compressor, exhaust pumps, and equipment in the semicommercial sugar plant.

Miscellaneous repairs and alterations.—This work included building foundations for a variety of equipment, relining boiler settings, and several alterations to buildings such as the excavation for the new spectroscopic laboratory and the new room for precision length measurements.

Library books.—The number of volumes accessioned this year was 1,552, making the total number of accessioned volumes 30,818, as compared with 29,362 last year; 730 scientific and technical periodicals are received by the bureau's library.

Travel.—Provision was made for necessary travel to consult with experts at meetings of scientific and technical societies, travel of members of the bureau's visiting committee, and travel in foreign countries on cooperative work of the bureau with other national standardizing institutions.

Contingent expenses.—Part of the contingent expenses of the bureau and of the Department of Commerce as a whole have also been provided for.

IMPROVEMENT AND CARE OF GROUNDS ($12,000)

Improvement of grounds.—Considerable progress has been made in the improvement of the grounds, particularly in the plot lying along Connecticut Avenue. This part of the property has been graded and planted and is now in a fairly satisfactory condition. A new entrance walk has been completed which adds greatly to the comfort and convenience of the employees.

TESTING STRUCTURAL MATERIALS ($230,000)

Building codes.—The building code committee published its Recommended Building Code Requirements for Unit Working Stresses in Building Materials and has made substantial progress on its report on fire-resistive construction. At least 85 municipalities throughout the country have used recommendations of the committee in code revisions. The committee suffered a heavy loss in the death of its chairman, Ira H. Woolson, on May 8.

City planning and zoning.—The Standard State City Planning Enabling Act was completed in February by the Advisory Committee on City Planning and Zoning and within three months was utilized in laws enacted in three States. New editions of the Standard State Zoning Enabling Act (which has now been utilized in the laws of at least 28 States), a Zoning Primer, and a City Planning Primer were issued and reports on zoning progress have been issued from time to time.

Standard State Mechanics' Lien Act Committee.—The voluntary committee, which is drafting a recommended standard State mechanics' lien act, circulated a preliminary tentative draft and is now perfecting it with the aid of the comments and criticisms.

Statistical work.—Monthly prices for 24 building material items as paid by contractors in about 50 cities have been obtained, issued regularly, and republished in a number of trade papers. They are also used in compiling index numbers of the price of materials for small frame and brick houses. Current statistics on building activity, building costs, production, consumption, and stocks on hand of

the principal building materials were printed regularly in the Survey of Current Business and its advance releases.

Cooperation with Government and private agencies on building and housing problems.—Cooperation was continued with Federal, State, and local governmental agencies, and with private organizations concerned in building and housing. Material relating to construction was furnished for several publications of the Bureau of Foreign and Domestic Commerce, a number of drafts of building codes were reviewed, and problems relating to city planning and zoning, building costs, and home ownership were taken up in conjunction with such groups as Better Homes in America, the American Construction Council, the American Civic Association, and bodies representing architects, engineers, and business and labor groups connected with construction.

Structural steels high in silicon.—A technologic paper has been issued describing the properties of structural steel high in silicon which has an exceptionally high yield point.

Standard finishes for builders' hardware.—In cooperation with manufacturers the bureau established in 1924 a simplified and standardized line of 25 hardware finishes. Sixteen of these are fixed as regards color by the composition of the metal. The remaining nine, so-called "oxidized" finishes, are dependent upon the process employed in the finishing room. Unfortunately they also tend to change color slowly with time, particularly when exposed to strong light and humidity. Twenty-five new sets of these nine finishes were distributed to interested manufacturers for use as reference standards. At the same time a spectrophotometric study was made of each finish, including the determination of the dominant wave length, purity, and reflective value. The color characteristics of these standard finishes have thus been established independently of any material standard.

Vitreous china plumbing fixtures.—Through the hearty cooperation of the manufacturers the standardization of vitreous china plumbing fixtures has made steady progress. This has included simplification, the development of a standard nomenclature, grading rules, and dimensional standards. Forty thousand copies of the pamphlet embodying the above standards are being distributed by the manufacturers to architects and plumbers.

Refractory bricks and clays.—Tests of 17 brands of clay refractories and of each individual material used in their manufacture show a wide range in thermal expansion, elasticity, and mechanical strength values, although the pliability, or maximum elongation at rupture, did not vary greatly from an average of about 0.04 per cent. The relative qualities of the various materials in any one mixture may have an important bearing on the properties of the product irrespective of the method of manufacture. A method has been developed by which it may be possible to estimate quite closely the relative resistance of sagger clays to spalling in service. At the Columbus station cooperative work with the American Society of Mechanical Engineers has been continued in a study of the cause and control of brick failure in boiler settings.

Cast iron for enameling purposes.—A new method of distinguishing between irons, with respect to their tendency to produce blistered

ware when enameled, has been developed. The range of conditions under which an iron can be enameled without blisters determines whether it is good or poor. This method of "range finding," besides being an important step in the solution of the problem of differentiating between enameling irons, helps to eliminate blisters in the manufacturer's output. Preheating the iron before coating it with enamel helps to eliminate blisters, since the gas has a chance to evolve at a temperature below the fusion point of the enamel.

Maintenance of interior marble.—This cooperative investigation with the National Association of Marble Dealers has been completed. A paper now being printed relates to methods and preparations for cleaning interior marble, means of treating stains, and preservation of the natural appearance.

Methods of cleaning limestone masonry.—An apparatus which employs high-pressure steam and water has been given several practical trials and appears to meet the requirement of cleaning without injury to the stone.

Stone preservatives.—Exposure tests in progress for six years indicate that the only type of treatment which will endure for this period is the paraffin type.

Frost action.—Frost tests indicate that in severe climates poor grades of limestone and sandstone will probably show extensive decay in 25 years, while other grades might last three or four centuries. Efflorescence may produce more rapid deterioration than frost, and decay of stonework within two or three years after a building is erected can usually be attributed to this cause.

Sound-absorbing gypsum plaster.—Ninety per cent of the acoustical defects of auditoriums, theaters, and churches may be remedied by a sound-absorbing plaster. A gypsum plaster composed of 2 parts of volcanic tufa, 1 part sand, and 1 part of calcined gypsum and containing 2 per cent by weight of the calcined gypsum of a mixture of calcium carbonate and potassium alum in molecular proportions with retarder has been found to have the sound-absorbing properties desired.

Method of analysis of hydrated lime.—There is no chemical method of analysis of hydrated lime which gives information relative to the CaO, MgO, $Ca(OH)_2$, $Mg(OH)_2$, and $CaCO_3$ contents when all are present. A thermochemical method of analysis has been developed. The sample is heated at succeeding temperatures for definite periods of time, and the loss in weight is plotted against temperature. Breaks occur in the curve indicating the dissociation of the $Mg(OH)_2$, $Ca(OH)_2$, and $CaCO_3$, and the loss in weight due to the decomposition of each constituent may be obtained. From these data the percentages of the compounds may be calculated.

Adhesion of mortar to sand-lime brick.—Tests on adhesion of mortar to sand-lime brick show that, so far as adhesion is concerned, a brick which absorbs some water from the mortar is more desirable than a nonabsorptive brick. Brick which absorb water quite rapidly should have their rate of absorption reduced by wetting. Wetting brick having a low rate of absorption decreases the adhesion. Bricks of one make may vary so much in rate of absorption that the adhesion of the mortar is affected more by this than by changes in mortar composition.

Strength of hollow-tile and concrete slabs.—Tests of 102 beams representing different types of hollow-tile and joist-floor construction show that the value of the tile in resisting shearing stresses is a function of their compressive strength.

Strength of brickwork.—One hundred and fifty-nine walls, 9 feet high and 6 feet long, and 130 smaller masonry specimens have been tested. Data have been secured on the factors which affect the strength of both solid and hollow walls of brick.

Strength of hollow-tile walls.—An investigation of the compressive and transverse strength of walls built of a specially designed hollow tile indicated that mortar and workmanship are the most important factors affecting the strength of these walls.

Concrete mine stoppings.—Tests of 12 slabs show approximately equal stresses under static pressures and under pressures produced by explosions.

Stevenson Creek experimental dam.—The Stevenson Creek experimental dam, erected solely for test purposes under the supervision of a national committee, has been built to a height of 60 feet, and the tests at this height have been completed. During the studies of the data progress reports have been issued which indicate that a reduction in the cost of arch dams may be effected by applying the results of this work.

Durability of aggregate.—The necessary apparatus has been assembled and 36 samples of aggregate collected from all parts of the United States, representing granites, trap rocks, sandstones, limestones, slags, and miscellaneous varieties of gravels. All samples have been carefully graded, and durability tests are now in progress involving several different treatments. It has been noted that the boiling and drying treatment and Na_2SO_4 treatment are the most severe and are apparently equally effective.

Limestones are apparently disintegrating more rapidly than other aggregates. The gravels contain so many varieties of stone that disintegrated particles are found in almost all of them, but by far the greater number are sound. Granites have not been affected and only occasional pieces of trap. Sandstone and slags have shown signs of breaking up.

Methods of testing cement.—In cooperation with the American Society for Testing Materials, comparison tests were made on 32 brands of cement, trying a proposed method of pouring a neat cement briquet, to replace the mortar briquet as a test specimen for cement. The new type of specimen has advantages over the old, but the preparation must be adjusted to allow for variations in the normal consistency requirements. A study of the linear changes of neat cement specimens—one with normal consistency, the other with 42 per cent excess water—showed various contractions in volume during setting, ranging from no change to 0.09 per cent, the values for the individual cements scattering between these limits.

Inspection of cement.—During the year there have been tested and shipped under bureau supervision 683,362 barrels of cement. Because of the increased shipments of small quantities of cement at widely separated points, especially in the Northampton district, the testing and shipping of a slightly smaller amount of cement than last year has required a greater number of inspector hours.

Comparison tests on samples of three identical cements have been made each month at the Washington and the three branch laboratories. This has resulted in a considerable improvement in the uniformity of results obtained at the four laboratories. A device to measure the pressure applied in making mortar briquets has been installed and has helped to secure uniform results. Fifty No. 200 sieves were tested, and 427 standard fineness samples of cement were distributed.

Branch laboratories.—The bureau maintains three branch laboratories. The Northampton (Pa.) laboratory is used exclusively for the inspection and testing of cement and being advantageously situated in the Lehigh Valley cement-producing district, supervises the major portion of the Government purchases for tested cement. The Denver laboratory tests cement in the territory west of the Mississippi River and is engaged in the study of available concrete aggregates used by the Reclamation Service. The San Francisco laboratory tests cement and miscellaneous materials purchased by the Government on the western coast.

TESTING MACHINES ($38,000)

Calibration of testing machines.—The proving ring for calibrating testing machines in industrial plants has been further developed, so as to provide a reliable instrument for transferring loads applied by the dead weight testing machine (see "Equipment") to the machine under calibration. Proving rings having capacities of 10,000 and 100,000 pounds are now nearing completion.

Compressive strength of brickwork.—This investigation, in cooperation with the Common Brick Manufacturers' Association, has included the construction and testing of 168 brick walls, 6 feet wide, 9 feet high, and 8 or 12 inches thick. In addition, similar tests have been made on approximately 100 wallettes. The variable factors include brick, mortar, type of construction, effect of wetting, and workmanship. The laboratory work is nearing completion, and the results are being prepared for publication.

Welded rails.—A series of repeated impact tests on welded rail joints in cooperation with the American Electric Railway Association and the American Bureau of Welding has been completed. The failure of street railway rail joints in service is a source of great expense from the standpoint of maintenance, reduces the speed and effectiveness of the service, and greatly increases the noise of operation. Work on the development of a welded joint which will have a longer life is in progress.

Welded structural members.—In cooperation with the American Bridge Co. and the American Bureau of Welding a compression test was conducted on a steel column in which welded joints replaced the customary riveting. The results showed the column to be even stronger than expected, and this method of construction seems likely to come into more extensive use, particularly where noise is objectionable.

Interlocking rib tile walls.—There is much interest at present in buildings which will show greater resistance to earthquakes and hurricanes, and for this purpose walls with greater transverse strength are necessary. The strength of walls constructed of tile

with vertical ribs which interlock in the center of the wall has been investigated. The horizontal joints between the tile on the outside surface of the wall were also staggered with respect to corresponding joints on the inside surface. Tests of these walls showed a greater transverse strength than is obtained in tile walls of the usual construction. The compressive strength of the two types is about the same.

Copper roofing.—In cooperation with the Copper and Brass Research Association the conditions affecting the life of copper when used for roofing and for valleys and flashings have been investigated. The properties of sheet copper and of different methods of joining the sheets were also studied. Results have already been obtained indicating that the construction of copper roofs can be greatly improved.

INVESTIGATION OF FIRE-RESISTING PROPERTIES ($28,100)

Fire-loss statistics and fire prevention.—Data for a paper on the seasonal variation in the fire loss obtained from State and press reports have been tabulated and charted.

Experimental methods have been developed for gauging the fire hazard of discarded matches, cigars, and cigarettes, and a number of tests were made to ascertain the relative hazard of several kinds of interior floors and wall coverings. Cigarettes are more likely to cause fires than cigars, because, in general, they burn longer after being thrown away.

Insulated safes.—Five fire tests of insulated record containers were made for Government departments and two for manufacturers.

Fire intensity and duration.—The larger structure, 30 by 60 feet in floor area, was burned out once with record-room occupancy and once with desks and filing cabinets. Four tests with metal furniture were made in the smaller structure, which, supplemented by a test with records on metal shelving due to be made in July of the present year, will complete the tests with office occupancy.

The severity of the fires with wood furniture was equivalent to approximately the first hour of the standard furnace test when wood flooring, furniture, and contents weighed 10 pounds per square foot, 1½ hours with 15, 2 hours with 20, and between 5 and 8 hours with the record rooms having 50 to 60 pounds per square foot of shelving and records.

Strength of materials at high temperatures.—The work on compressive strength of steel and cast iron was completed, 65 tests at temperatures of 750° C. being made on rounds and rolled shapes having slenderness ratios (l/r) from 22 to 144.

Fire tests of roofing materials.—Brand, flame, and spread tests were made on 126 decks of painted or chemically treated wood shingles, both new and weathered. Approximately the same number of tests were made on decks of weathered wood shingles and asphalt prepared roll roofing and shingles removed from building roofs 12 to 30 years old. Tests were also made of copper shingles, zinc standing seam roofing and shingles, copper-clad asphalt shingles, and asphalt saturated and coated asbestos felt roll roofings.

Fire resistance of heavy walls.—The fire tests of hollow tile walls were completed, 45 tests made during the year being of plastered, brick-faced, or furred walls, 12 or 16 inches in thickness, and of 8-inch walls made of tile for which the clay had been especially prepared by varying amounts of grinding, pugging, and admixture of combustible filler.

A supplementary series, consisting of fire-endurance tests of four brick walls and four hollow-tile walls that had been seasoned by accelerated methods to constant weight before testing, was added to obtain information on what effect the free water present in masonry walls for a considerable period after building has on the temperature transmission through the wall.

INVESTIGATION OF PUBLIC-UTILITY STANDARDS ($100,000)

Measurement of high voltages and large currents.—Work has continued on the absolute electrometer designed to give a fundamental basis for measurements of voltages up to at least 250,000 volts. The year has been devoted largely to perfection of the actual measuring and weighing devices—gauge rods, balances, weights, and controls. In order to correlate electrometer measurements of effective voltage with crest or maximum voltages as measured by the sphere-gap or the corona voltmeter, an electrostatic curve-tracing apparatus has been developed. A study of humidity effects in the corona voltmeter has been made, showing that humidity has an appreciable effect under some conditions. A tubular noninductive oil-cooled shunt for 1,000 amperes has been completed, and studies of its performance have been made as a basis for the design of similar shunts for larger currents.

Electrolysis and soil corrosion.—Papers on methods of electrolysis testing and on applications of the earth current meter are in press. One on methods of electrolysis mitigation has been prepared and submitted to the American Committee on Electrolysis for discussion. Since many different interests are affected and there are wide differences of opinion regarding the choice of methods for preventing damage by stray currents, publication of this paper is likely to be delayed. Some 2,000 specimens of metals and protective coatings buried in various soils have been examined during the year. These constitute the second lot of specimens in this investigation which is planned to run for a total period of 10 years, and the preliminary nature of the present results is emphasized. Nevertheless, there is very widespread interest, and reports have been presented at four meetings of technical organizations.

National Electrical Safety Code.—All five parts of the new (fourth) edition of the National Electrical Safety Code have now been published as handbooks of the bureau.

Government telephone surveys and patent suits.—The numerous changes which have been made in location of bureaus in Washington, as well as changes in character and amount of business handled, have made necessary the continuation of telephone service studies under the auspices of the chief coordinator's office. Detailed studies are also being made to determine the best and most economical arrangement of telephone service for the group of new buildings recently authorized by Congress. These surveys, with a few others

outside the District of Columbia, the arrangement of general telephone service contracts, and the assistance given the Departments of Justice and War in defending suits for infringement of patents have occupied the full time of the bureau's telephone section.

Gas water heaters.—An investigation of the behavior of water heaters was carried out in cooperation with the testing laboratory of the American Gas Association in order to establish specifications for these appliances. The various factors relative to burner design and service conditions at the burner when using different fuel gases are being investigated. A theoretical study of the characteristics of flames for the purpose of adapting the results to the investigation of gas burners and appliances has been in progress.

Production of water gas.—A review of the entire literature relating to the economic factors involved in the production of water gas from both coke and coal has been made and should be of considerable value to public utility commissions.

Gas analysis apparatus.—A thermal conductivity apparatus was constructed for the Bureau of Mines for use in gas analysis in the investigation of mine explosions.

TESTING MISCELLANEOUS MATERIALS ($44,090)

Variety of materials tested.—A great variety of chemical and physical tests were made for Government departments on paints, varnishes, roofing, and waterproofing materials; rubber; writing materials; boiler waters and compounds; technical chemicals; and detergents. A large number of miscellaneous materials were tested to determine their fire hazard in order to furnish data to guide the Steamboat Inspection Service in making rulings on the transportation of commodities on passenger vessels.

RADIO RESEARCH ($49,800)

Radio-frequency measurements and standards.—The radio work was largely concentrated on two main problems—the improvement of frequency measurements and the development of radio aids to air navigation. The latter work was largely supported by funds transferred from the Aeronautics Branch of the Department of Commerce and will be described under "Transferred funds." The development of broadcasting and increased uses of radio generally rendered imperative greater accuracy in the measurement of frequency or wave length. Experiments to improve radio-frequency standards were conducted, apparatus was tested, and standards were disseminated in such a way as to make them of most value in maintaining broadcasting and other stations on the correct frequencies. The piezo-oscillator received much attention. With the cooperation of other Government departments and large electrical companies a program of research was begun looking to the development of this apparatus and its standardization to the highest possible accuracy, the aim being to secure a very considerable improvement over the present attainable accuracy of about 0.01 per cent. Comparisons with all important radio laboratories abroad showed that most of them were in agreement to the order of 0.01 per cent, but it is highly desirable

to establish absolute frequency values with a certainty of 0.001 per cent, and to do so will require much more research and development.

Radio wave phenomena.—The work on radio wave phenomena has included studies of fading and its correlation with other natural phenomena, such as terrestrial magnetism and electrical conditions on the sun. A definite connection appears to exist between solar phenomena, such as the rotation of the sun and the sun-spot cycle and radio conditions on the earth. Methods of measuring radio field intensity have been developed, as well as means for calibrating apparatus for these measurements. This work is increasingly important in view of the close control exercised by the Federal Radio Commission over the power and interference production of broadcasting stations.

COLOR STANDARDIZATION ($9,000)

Color standards in industry.—Color plays a much more important part in industry and commerce than is generally realized. Requests are received in large numbers for advice on the standardization of colors for railway signals, highway signals and signs, building materials, paints, dyes, food products, and many other commodities. In no field probably is it more difficult to set up a satisfactory standard because the science of colorimetry lies in that borderland between physics and psychology where so much depends on the human observer. Nevertheless, progress is being made. A standard for artificial sunlight has been established for colorimetric purposes, many light sources have been graded, and numerous phases of the psychophysical aspects of the problem have been studied.

Visual color responses and their physical stimuli.—While colorimetry is preeminently a psychophysical subject, the basis of color specification lies in physical measurements of emission characteristics of light scources, transmissive characteristics of transparent materials, and reflective characteristics of more or less opaque materials. In cooperation with the Munsell Research Laboratory, progress has been made in the study of colorimetric sensibility, the elementary color excitation functions, and the analysis of color in terms of dominant wave length and purity, all of which serve for the colorimetric interpretation of these physical characteristics.

Standard Lovibond color scale.—For several years a research program has been under way with the object of finding an adequate basis for measuring and specifying color in trade. An important part of this program has been completed in the establishment of standards for Lovibond red and yellow glasses used in the vegetable oil and other industries. Having such standards, the next step is the calibration of perhaps several hundreds of these glasses for the trade, very slight differences in which often lead to disputes involving thousands of dollars.

Apparatus for measuring the reflective characteristics of materials.—For specifying the color of opaque diffusely reflecting materials a means of measuring reflectance under various conditions of illumination and as a function of both wave length and angle of view is necessary. A satisfactory experimental solution requires very complicated apparatus. During the past year this was designed, constructed, and placed in successful operation.

INVESTIGATION OF CLAY PRODUCTS ($47,000)

Use of feldspar in whiteware.—This investigation has been continued by further tests of grain fineness, mineral constituents, thermal dilatation, relative translucency of vitreous bodies in which the feldspar is the only variable component, and resistance of glazed ware to thermal shock. Specimens for the thermal shock test represented various combinations of feldspars in the glaze with the same and other feldspars in the bodies on which the glazes were applied. The data indicate that (1) screen analyses by various laboratories may differ sufficiently to make specifications to closer than ± 0.5 per cent of little significance, (2) differences in chemical analyses are sufficient to justify further investigation to determine the cause and control of present variations, (3) refractoriness of feldspar increases and the softening range decreases with increase in K_2O, (4) softening points range from that of cone 4 for soda felspar to that of cones 9 to 10 for potash feldspar, (5) translucency for vitreous bodies containing potash feldspars increases with increase in the K_2O content of the feldspar, (6) mechanical strength is affected more by the method of firing than by the feldspar, (7) thermal expansion of vitreous bodies is increased by rapid firing and by increasing the Na_2O content of the feldspar.

The work on whiteware also includes a comparison of English and American china clays. All of the usual standard tests for both unfired and fired clays are to be covered, and a study of 17 English clays is now in progress.

Drying of clay bodies.—Preliminary drying studies of 12 typical clays have been completed, a method of routine testing developed, and a report correlating the drying results with previous investigations of the same clays with respect to water smoking and oxidation is in course of preparation. At the Columbus branch 19 clays have been selected for the purpose of studying the qualities characterizing clays used in the manufacture of heavy clay products.

Workability of clays.—The power efficiency of extrusion machines as affected by various combinations of dies, spacers, and type of auger has been studied, using a clay which did not change in workability after repeated extrusions. The data indicate that the single wing auger (6-inch), 1° taper die and 6-inch spacer is the most efficient combination for the clay used.

Vitreous enamel ground coats.—The effects of different proportions of flint and feldspar and various combinations of fluxes have been studied. In general, flint in the refractory portion and sodium oxide in the flux portion were most resistant. Boric oxide increased resistance to mechanical shock in the series of ground coats containing flint and feldspar in approximately equal proportions. Variations in expansivity influenced resistance to mechanical and thermal shock less than is the case in cover coats. A light-colored ground coat of sufficient adhesiveness is hard to obtain without the use of cobalt, which produces a dark color. A new test for measuring adhesiveness has been devised. Opacifying materials have also been studied to determine which can be used in the mill batch of a ground coat without danger of reaction with the metal base and evolution of gas. Zirconium oxide and sodium antimonate have appeared satisfactory.

Methods of treating the metal to increase the adhesiveness of the enamel have been tried with promising results.

Consistency of enamel suspensions.—This investigation has been completed. A new component of consistency which is called "set" (of which the draining period is a measure) has been discovered, and a new method worked out for computing and expressing "relative mobility." Correlation of data obtained in two factories led to the conclusions that (1) the weight of enamel slip retained on a unit area of the iron base is a function primarily of yield value and secondarily of "set," (2) mobility can be completely controlled in practice by varying the water content of the slip, and (3) the measure of "set" known as draining period is roughly a hyperbolic function of mobility.

Study of glazes.—The properties of tensile strength and elasticity of about 85 glazes have been determined and data correlated to develop laws regarding the effect of various components of the glazes on these properties.

As a correlary to this work, some study has been made on the type of strain present in a glaze fired to a body. The evidence so far shows glazes which have crazed to be in tension and those of good fit to be in compression, as a general rule.

STANDARDIZING MECHANICAL APPLIANCES ($27,800)

Elevator safety interlocks.—Work on elevator interlocking devices has been extended to include numerous reliability tests of commercial interlocks requested by regulating bodies. The results are used as the basis for approval by several of the Government departments, by the District of Columbia, by various municipal and State governments, and by a group of casualty insurance companies.

Elevator research.—An investigation of the performance of elevator safety equipment, particularly oil buffers, undercar safeties, governors, and their associated mechanisms, is being conducted under a fellowship established by the American Engineering Standards Committee. The ultimate purpose of the work is the preparation of specifications for performance tests of elevator safety equipment.

An elevator machine has been installed, and special instruments are being developed to measure the deceleration, which takes place in a relatively short time and may attain a value three times that of gravity.

Altitude chamber for testing instruments.—This is a steel tank, large enough to accommodate two observers, in which the pressure can be lowered to correspond to an altitude of 30,000 feet. It has been useful in adjusting and testing instruments for aircraft and in calibrating mercurial barometers by comparison with a standard instrument. Temperature control within the chamber is now being installed.

Testing of engineering instruments and mechanical appliances.—There has been an increase of approximately 20 per cent in the testing of engineering instruments and mechanical appliances, including the calibration of stream flow meters, the testing and investigation of new fire extinguishing devices, and the testing of devices and equipment purchased by the Government departments under performance specifications.

Radiator air valves.—The investigation of radiator air valves has been continued at the request of the Supervising Architect's Office. Definite performance specifications have been in use during the past six months.

INVESTIGATION OF OPTICAL GLASS ($20,520)

Production of optical glass.—In studying the factors affecting the quality of optical glass during melting, molding, and annealing, a total of approximately 21,000 pounds of glass of four different kinds were made in 18 pots, one of which contained about 4,000 pounds. Most of the perfect glass obtained was molded into prisms and lens blanks of various sizes from which the naval optical shop received 21,441 blanks.

Viscosity.—The friction of the rotating parts of the viscosity machine has been reduced to such an extent that the friction correction for any load is now definitely known, and errors in viscosity determinations caused by uncertain or variable friction correction are entirely eliminated. This will increase the accuracy of measurements and permit a more thorough study of other variable conditions affecting viscosity determinations.

Annealing or the reduction of strain in glass.—Recently it has been shown that the temperature at which glass is annealed has a decided effect on the index of refraction (and also density) of the glass. Glass from the same melt may have different indices of refraction if annealed at different times. These differences are great enough to explain differences in focal lengths of similar optical systems and variations from computed focal lengths which previously were thought to be caused by lack of homogeneity in the original glass or faulty surfaces. Critical studies on this phase of the work are being continued.

Large glass disk.—A large glass disk for a reflecting telescope was satisfactorily cast by pouring the molten glass into a mold, which is at the same time an electrically heated annealing furnace. The disk, made of borosilicate crown glass, is approximately 70 inches in diameter, 12.5 inches thick, and weighs about 4,000 pounds. The cast-iron furnace (or mold) weighs 5 tons and the insulation (sil-o-cel) about 2 tons. The glass is allowed to cool about 2° C. per day, and the annealing will require a constant temperature for about six weeks, after which slow cooling will again be started. The initial cooling, annealing, and final cooling of this disk will take about 10 months, and since it was cast in May it will not be cold until about February.

INVESTIGATION OF TEXTILES, ETC. ($35,000)

Physical characteristics of mohair fiber.—Data regarding the physical characteristics of mohair fiber were obtained to supplement the technical and economic information on the mohair industry now being collated by the Departments of Commerce and Agriculture. Strength and diameter measurements were made. A photomicroscopic study of the mohair fiber and mohair kemp was prepared. Cross sections were prepared thin enough to show the cellular structure of the kemp as compared with the almost solid structure of the mohair fiber.

A resilience test for fabrics.—A method of measuring the resilience of a textile fabric has been developed in connection with a determination of the characteristic properties of silk as contrasted with mercerized and doped cotton fabrics. The apparatus employs a balance acting as a loading device and a movable platform on which a test specimen is placed. Measurements are made by placing a fold of the fabric on the platform, then applying compression by means of the balance, then noting the amount of compression of the fold of the fabric under gradual loading and its return when the load is removed.

A stress-strain test for rayon yarns.—An investigation of the effect of moisture on the properties of rayon required a more accurate test method than was available. The method developed differs from the lea test on which it is based, in the control of the tension of the individual strands which make up the test specimen.

The apparatus consists of a U-shaped rod on which the yarn is wound by means of a yarn winder (ordinarily used for evenness inspection), a tension device consisting of three highly polished metal disks, and a transfer clamp for taking the specimen from the U rod to the jaws of the testing machine.

The results obtained on rayon yarns using this "equitension lea method" have shown that further elaboration of technique of multiple yarn test methods would not be warranted unless more sensitive strength machines are used; that is, the variations are within the limits of the machine.

Standardization of paper-testing methods.—In cooperation with the Technical Association of the Pulp and Paper Industry numerous official paper-testing methods were developed. A member of the bureau's staff acted as chairman of the association's paper-testing committee which conducts the development work. Twenty-one methods have been completed and officially adopted by the association.

Paper fibrous raw materials.—Successful results were obtained in paper-making tests of various fibrous raw materials. It was found by semicommercial experiments that paper equal to that made from high-grade rags could be produced from the Caroá plant, native of Brazil. Tests of waste mail pouches made for the General Supply Committee demonstrated their excellent paper-making value and resulted in disposal of them to paper makers at an increased annual profit of $17,000. A good grade of wrapping paper was produced from waste fibrous material, which is a by-product of the manufacture of manila rope, at the Boston Navy Yard. This opens up the possibility of profitable disposal of it to paper makers.

Paper currency.—Treasury Department statistics show that the cooperative research with the Bureau of Efficiency and the Bureau of Engraving and Printing on improving the quality of United States paper currency has increased its average life to 10 months as compared with the former figure of 7 months. The importance of this work is evident when it is remembered that the cost of producing a year's supply of paper currency is around $10,000,000. One of the chief contributing factors to the greater wearing quality of the present paper currency is the development in the experimental paper mill of a distinctly new type of paper characterized by great fiber strength.

SUGAR STANDARDIZATION ($38,160)

Production of hard refined levulose.—The production of levulose has resulted in great interest throughout the country in the possibility of a new American industry. Approximately 100 pounds of this sugar was manufactured and distributed to various parties for experimental purposes. A part was used with diabetics, of whom there are about 2,000,000 in the country. Having satisfactorily demonstrated that it is a physical possibility to produce granulated levulose in quantity, a semifactory scale experimental plant has been designed and is now being installed. This is intended to supply the engineering information necessary for designing a commercial factory.

Production of dextrose.—The utilization of corn by the dextrose industry, an outcome of the bureau's activities, has apparently gone far to solve the surplus corn problem. During 1926 the production of crystalline dextrose amounted to over 200,000,000 pounds, and the demand now exceeds the capacity of the producing plants. Production has doubled each year for the past three years.

Carbohydrate investigations.—One new sugar compound, the existence of which was predicted by theory, has been made in the laboratory, and improved methods for preparing various sugar compounds have also been developed. Published researches bearing on the relations between rotatory power and structure in the sugar group as carried on at the bureau are extensive and scattered over a number of years in various scientific magazines. A 142-page report has been published in which the essential discoveries have been collected and correlated. The need for this has been amply proven by the requests for the publication. It covers a number of important new sugar compounds which have been prepared and gives data relating to the structure of the compound sugars which have been obtained by the preparation of compounds of six sugars—lactose, cellobiose, maltose, glucose, mannose, and xylose.

Import sugar and molasses.—The sucrose in imported raw sugars and molasses is the largest single producer of revenue from the tariff. The supervision of the testing of these materials in the customs laboratories was carried on with such success that the Government was involved in practically no expense for litigation during the current year. The increase in the importation of molasses necessitated further studies with the object of increasing the precision with which the duty could be determined. The methods developed have been adopted throughout practically the entire molasses industry.

Duty on Cuban granulated sugar.—The Treasury Department was confronted with a new problem in collecting revenue on granulated sugar grown and refined in Cuba. The problem was solved at the bureau's suggestion by stationing a Federal inspector at the plant to supervise the testing and packaging of the sugar. His expenses are paid by the manufacturer, and duty on 100 per cent sugar is paid on each shipment. This avoids the necessity for any inspection when the sugar reaches the United States. The Government is, therefore, receiving a large increase in revenue at no additional expense.

GAUGE STANDARDIZATION ($38,320)

Gauges for oil industry.—About 65 per cent of the limit gauges tested have been for use in the petroleum oil industry. Marked progress has been made in the standardization of oil-well casing, drill pipe, cable drilling tool joints, and pumping equipment.

Improvement of gauges and gauge steels.—The design of threads and the heat treatment and accelerated aging of gauge steels to secure dimensional stability have been studied.

It has been found in practice that the percentage of full thread depth in nuts specified by the National Screw Thread Commission is in some cases unnecessarily high, and that it results in excessive power requirements for tapping and in excessive tap breakage, especially in the smaller sizes. Experiments to determine the maximum size hole that can be permitted in a nut and still develop the full strength of the mating screw show that the minimum depth of engagement may safely be reduced somewhat below the 75 per cent specified by the commission, probably as low as 65, and possibly to 60 per cent, or even less on the smaller sizes.

A ball-race steel and a straight carbon steel have been given accelerated aging tests. The steels are immersed in boiling water for 24 hours and then for successive periods of 100 hours each, the change in length of each specimen being determined after each period of boiling. One group of specimens of ball-race steel was practically stable after 24 hours boiling. Another group was stabilized after 124 hours boiling. These specimens have been measured at frequent and regular intervals during the past eight months, and no change greater than 0.00001 inch in a 4-inch specimen has been found. Other specimens of ball-race steel and all of the straight carbon steel specimens were given a different heat treatment and were not stabilized after 1,400 hours of boiling.

Improved equipment and testing methods.—An improved method of measuring the thread angle of ring gauges has been developed, and plaster of Paris has replaced sulphur and graphite as the most suitable material for making casts of threads in ring gauges.

Two projection lanterns of an improved design have been constructed—one for the Ordnance Department of the Army and one for the Naval Gun Factory, Washington, D. C.

Cooperation.—Under this fund cooperative work has been carried on with the National Screw Thread Commission, the Federal Specifications Board, the Gauge Design Committee, and the American Petroleum Institute in the field of design and test of screw threads and limit gauges.

INVESTIGATION OF MINE SCALES AND CARS ($12,800)

Tests of tipple scales.—The mine-scale testing unit operated in the States of West Virginia and Ohio, making tests of 186 tipple scales at coal mines. Of these 79, or 42.5 per cent, were found correct within the prescribed tolerance. Incidental tests of 9 motor truck and wagon scales were also made by this unit.

This figure for accuracy is somewhat lower than last year, but it is subject to considerable fluctuation from year to year because of

the fact that the figure for a single year is not, and can not be, representative of the coal-producing regions as a whole. The scale-testing equipment works in different regions each year to meet special demands, and it takes two or three years to cover the whole territory. General experience over a period of years shows a gradual improvement in this type of scale.

METALLURGICAL RESEARCH ($43,140)

High-speed tool steel and the machinability of steel.—The study of the effect of impurities and of added elements on the performance of high-speed tool steel has proceeded as usual. A report was issued on machinability of alloy steels under roughing cuts, and experimental study of finishing cuts was begun, following the suggestions of the metallurgical advisory committee.

Steel for carburizing.—In cooperation with the Bureau of Mines, the study of "abnormality" in steel for carburizing is nearly completed, and a progress report has been published. A final report is in preparation. This peculiarity in some steels has been shown to exist, although heretofore it has been doubted by some metallurgists.

Corrosion of metals.—Besides cooperation with the Navy, Army, and National Advisory Committee for Aeronautics on the corrosion of duralumin, cooperative work with the American Society for Testing Materials on accelerated corrosion testing of zinc-coated materials has been carried on. Work on electrolytic methods for corrosion testing has been completed and a report published. All corrosion appears to be electrolytic in nature. A report on comparative tests of nonferrous materials is nearly ready for the press. Work on the effect of aeration in corrosion testing is under way. Cooperative work with the American Society for Testing Materials in laboratory and exposure tests of nonferrous screen wire cloth continues.

Molding sands.—Cooperation with the joint molding sand committee of the American Foundrymen's Association and with the Washington Navy Yard has continued. Methods for avoiding the burning-on of sand have been studied and a letter circular issued. Progress has been made in the development of apparatus and methods for determining the sintering point of sand and of rapid methods for moisture determination.

Substitutes for platinum.—The working of pure rhodium as a substitute for platinum, though difficult, seems on the way to solution. Successful accomplishment of this would mean a saving to the bureau on account of the amount of platinum now required in scientific apparatus.

Alloy steel.—A special iron-carbon-vanadium alloy of great hardness was prepared, and its applicability to balls for Brinell hardness testing was studied and a report published.

Bearings.—In cooperation with a research associate from a manufacturer, bearing metals such as are used on railroads have been studied as to wear resistance and impact strength at ordinary and at service temperatures.

Rails.—In cooperation with a research associate from an engineering firm, a study has been made of the properties of rails made from ingots cast with hot tops. In cooperation with the American

Railway Engineering Association, the Manufacturer's Rail Steel Committee, and the American Society of Civil Engineers' Committee on Stresses in Track, work has been done on the endurance limit of rail steel under repeated stress. Work is under way on axial loading endurance testing to study some factors that are essential in further work on the endurance limit of rail steel. The properties of rail steel at high temperatures are also being studied. These problems are attacked because of their bearing on the question of rail breakage, especially through transverse fissures.

HIGH-TEMPERATURE INVESTIGATIONS ($9,740)

Pyrometry of molten brass.—A study was made of the methods used in some 20 of the leading brass foundries to measure and control their pouring temperatures. The methods were analyzed and discussed in a paper presented before the American Foundrymen's Association and published as a part of their symposium on pyrometry. There appears to be a lack of knowledge of pyrometry in some foundries. Since most of the pyrometers on the market are satisfactory for measuring brass-furnace temperatures, there should be no difficulty in securing proper equipment, and undoubtedly the careful control of pouring temperature would result in a better product.

Thermoelectric properties of metals.—The thermoelectric properties of aluminum and thorium of high purity were determined as part of a program which is to include a study of all the metals which can be obtained in pure form. It is important to have on hand data of this kind to supply needed information when these metals are used industrially.

Heat losses from a hot-metal car.—The heat losses from a 75-ton hot-metal car were determined by the bureau at a plant of one of the large steel corporations. It was found that they were much less than from an open ladle. Steel could still be poured after remaining in the car for 40 hours. A paper on the subject was presented at a convention of the American Foundrymen's Association.

Pyrometry of ferrous materials.—A study has been made of the methods of observing the temperature in ladles and streams of molten cast iron. Observations made with a portable disappearing type optical pyrometer were compared with the true temperatures as found by the use of rare-metal thermocouples immersed in the metal and protected by graphite tubes. Work was carried out on a considerable variety of cast irons.

Melting point of palladium.—Using a value for c_2 of 1.4325 cm.deg. and taking the melting point of gold as 1,063° C., the melting point of palladium was found to be 1,553.5° C.

If the new value of c_2 (1.433 cm.deg.) is adopted for the international temperature scale, this value for the melting point will be lowered about 0.2°.

Melting point of platinum.—Work is in progress on the melting point of platinum, but the bureau is not yet prepared to announce the result.

SOUND INVESTIGATION ($10,580)

Acoustic properties of building materials.—Sound transmission measurements were made on 24 panels, mostly of masonry construction, and including 4 floor panels. A dead air space was found to be

the best sound insulator. No filling material can approach air in this respect. Measurements of sound absorption were also made on 20 substances commonly occurring in construction. These values of sound absorption are of importance in predetermining the acoustic qualities of a proposed auditorium. An acoustical plaster is also being developed which it is believed will remedy acoustical defects in about 90 per cent of the auditoriums, churches, etc., now having objectionable echoes.

Rating of tuning forks.—Requests are often received to measure the frequency of vibration of tuning forks submitted by makers of musical instruments. The bureau keeps no standard forks but compares every fork submitted with a primary standard of time in the shape of a freely swinging pendulum in a vacuum. The comparison of two vibrations as different in frequency as a tuning fork with a period of perhaps a thousandth of a second and a half-second pendulum presents considerable difficulty. During the past year a photographic method for accomplishing this has been developed by which the desired comparison can be made to 1 part in 25,000 in a period of 2 or 3 seconds.

INDUSTRIAL RESEARCH ($174,120)

Properties of rubber-sulphur compounds.—Samples ranging from 2 to 32 per cent of sulphur have been made, the density, dielectric constant, power factor, and resistivity measured, and the results give evidence of definite chemical compounds not previously known to be formed and dispel the mystery heretofore associated with vulcanization.

Storage-battery investigations.—A small-scale manufacturing plant has been assembled to make battery plates for experimental purposes in order to find out the effects of various materials and different methods of preparing grids and pastes. Several special investigations have been made to determine the conditions under which batteries should be shipped or stored in order to avoid deterioration. Effects of temperature during discharge have been studied with reference, first, to the design of batteries for use at low temperatures, as in airplanes, and, second, to the specification of conditions under which ratings of batteries should be determined. Other conditions affecting rating and performance of batteries have also been studied, and the results have been used in preliminary work on battery specifications for the Federal Specifications Board and in an American Institute of Electrical Engineers' report on standards for storage batteries.

Gases in metals.—Progress was made in the study of vacuum-fusion methods for gases in metals, especially for nitrogen, and representatives of manufacturers have studied the apparatus with a view to using it in commercial laboratories. Specimens of iron, the oxygen, hydrogen, and nitrogen content of which had been determined have been sent to scientists in England, Sweden, and Germany, who are also working on methods for analyses and intercomparison of the methods in use.

Metal spray.—The study of sprayed metallic coatings has been continued and the military aspects investigated in cooperation with the

Army and Navy. A coating of pure aluminum was found very effective in preventing intercrystalline embrittlement of duralumin.

Heat-resisting alloys.—Attention has been paid to the relation between behavior of heat-resisting alloys in long-continued loading tests at high temperatures and short-time tests made with especially sensitive equipment in order to secure more quickly and cheaply the data required by the engineer in designing high-pressure power plant equipment, oil-cracking stills, nitrogen-fixation apparatus, etc.

Quenching media.—Study of quenching in and quenching media for the heat-treatment of steel has continued. Methods for treatment of low carbon steel developed by industry with the aid of information contained in bureau publications on this project, are finding rapidly increasing commercial application.

Journal bearings.—The design of journal bearings is still almost wholly a matter of trial and error. As a part of a program, which is expected to put this entire subject on a rational basis, probably in chart of tabular form an investigation of the effect of running in before newly manufactured bearings are put in service has shown that subsequent friction losses can be considerably reduced and the load-carrying capacity increased.

Thermal expansion.—A research on the expansion of beryllium and its alloys has been completed; 11 tests have been made on nickel steels of compositions near but not at the invar composition, and 12 tests of stainless iron and other iron alloys have been made. This work is done in continuation of a policy adopted several years ago of working up complete data on groups of related alloys as early as possible after their appearance in commercial use.

New expansion apparatus.—A new and simple type of thermal expansion apparatus has been constructed and thoroughly tried out and found to be highly satisfactory for obtaining results of moderate precision (better than 2 per cent). It has already been used by two commercial laboratories and found to be well suited to their needs.

Dental materials.—Attention has been directed to studies of the shrinkage of dental castings, length changes in inlay wax when manipulated as in dental practice, porosity of castings, making inlays to exact dimensions, and the elimination of finlike defects and rough surfaces on castings. The results obtained have been of value to the Veterans' Bureau and to the office of the Surgeon General in the preparation of tentative purchase specifications for dental materials.

Optical design.—Optical calipers (which are free from the errors of contact methods) for measuring the wall thickness of compressed-gas containers, and an internal-inspection device for these containers, a new magnifying stereoscope for the United States Geological Survey, and a large-aperture four-component telescope objective for special work have been designed.

Investigations in atomic structure.—Progress in the development of artificial illuminants and of many important devices involving electron emission is dependent upon knowledge of the nature of collisions between atoms and electrons. Any contribution to our knowledge of the mechanism of radiation and of the structure of atoms is certain to result in new applications of value from the utilitarian standpoint. Notable examples of such development are the Coolidge X-ray tube and the entire field of radio tube design. In its studies

in the field of atomic physics the bureau has investigated the energy changes following resonance excitation of mercury vapor as well as problems relating to molecule formation in hydrogen and metal vapors.

With the mercury vapor exposed to λ2537 radiation, the intensity of the radiation thereby excited is more or less reduced by the addition of foreign gases. The detailed processes by which the energy of excitation is passed on to the foreign molecules are consistently explained.

In cooperation with the National Research Council an investigation of hyperfine structure has been carried on, especially the study of that of the λ2537 line of mercury in the magnetic field. The magnetic anomaly observed in this line was traced to a single one of the five components.

X-ray investigations.—The ordinary plane diffraction grating ruled on glass, receiving the radiation at nearly grazing incidence, has been successfully applied for measuring the wave length of the $K\alpha$ radiations of aluminum and carbon; $L\alpha$ radiations of copper, iron, and chromium; and the $M\alpha$ radiations of platinum. X-ray protective plasters consisting of various mixtures of materials containing the heavy atoms of lead and barium were investigated and the results published.

Photographic emulsions.—The performance of emulsions prepared with different bromides has been studied. Satisfactory explanation of these results by well-known chemical and physical principles fortifies the hope that eventually the whole subject will be reduced to a logical basis. One phase of the fundamental problem of photographic sensitivity has been dealt with by experiments on the sensitization by colloidal particles. These have definitely confirmed the possibility of sensitization by photochemically inert nuclei and indicated the mechanism by which this occurs.

Determination of sulphur trioxide in sulphur dioxide.—The refrigeration industry and the manufacturers of liquid sulphur dioxide have been unable to determine the amount of sulphur trioxide in sulphur dioxide, owing to the nonexistence of a satisfactory analytical method. An accurate method for this purpose has been worked out.

Light fading and washing of fabrics.—Investigation on light fading and washing tests has been made in cooperation with the research committee of the American Association of Textile Chemists and Colorists. A by-product of the work was a proposed classification of dyed fabrics according to their fastness of color. This was prepared to aid the Converters' Association and related organizations in their plan to label fabrics sold to retailers for the benefit of the ultimate consumer.

Fractional distillation of gases.—Studies of the separation of gas mixtures by fractional distillation at low temperatures and pressures have been productive of several new methods for the separation of natural gases with especial reference to the determination of natural gasoline fractions. A commercial apparatus was designed and has been used successfully in an industrial laboratory.

Sole leather.—Data on the comparative durability of chrome and vegetable tanned sole leathers, published some time ago, created

a demand for information as to the comparative durability of vegetable and chrome retanned sole leathers. Several series of tests have been in progress, using material supplied by five tanners. Retanned leathers used have varied from a light retannage with vegetable materials just sufficient to color the leather throughout its thickness to a heavy retannage which caused the leather to resemble vegetable leather in appearance. The results indicate that the light retanned leathers will wear about 75 per cent longer than vegetable and that the heavy retanned leathers will wear about 25 per cent longer than vegetable leather.

Acid in leather.—Work has been started to determine the effects of sulphuric acid on the life and properties of vegetable-tanned leather. Tanning of hides was carried out so as to produce standard leather samples tanned with ordinary quebracho, chestnut wood, and sulphited quebracho extracts. The last represents both the catechol and pyragallol types of tanning materials used by the industry. Samples of each of the standard leathers were treated with sulphuric acid varying in amount from 0 to 4 per cent. Each sample was then tested for original strength and stretch, and the remaining portion was placed in storage for the particular aging period involved. The aging periods to be used are 2, 4, 6, 9, 12, and 24 months. No results of aging tests are yet available. Considerable information was secured relative to the acid content of the leather by the use of the modified Proctor & Searle, total sulphur, and potentiometer methods. This research has been actively supported by the industry through an advisory committee.

Guayule rubber.—An investigation of guayule rubber, in cooperation with the Continental Rubber Co., has shown that by proper treatment during its preparation for market this rubber compares favorably with plantation Hevea rubber, the latter now comprising about 95 per cent of the world's supply. The commercial production of good quality guayule rubber will not only tend to stabilize the crude rubber market, but will also provide a cheaper native product which can be used as a substitute for the more expensive imported Hevea rubber.

Aging of soft rubber.—The first phase of the work on the aging of soft rubber compounds under different conditions of storage and exposure has been completed. The results show that heat, light, and oxygen contribute independently to the deterioration of rubber compounds, but that their effect is not the same on all compounds.

Antifreezing solutions for automobiles.—Further studies of glycerine-water radiator solutions, suggested by criticisms of their performance in service, have been undertaken as a preliminary to recommending Federal specifications for radiator solutions. A number of commercial antifreeze preparations have been examined, but no new materials of such merits as to warrant mention have been found.

Lubrication of aircraft engines under starting conditions.—Measurements of the rate of flow of some 35 commercial lubricating oils through the oil passages of a Wright J-4 engine, mounted in a cold chamber and slowly motored over, have been completed. The conclusion, earlier indicated, that neither the pour point of an oil nor its viscosity at 99° C. (210° F.) is sufficient to determine its performance

in the engine at temperatures below 0° C. has been confirmed. It is of interest to note that an oil reported to have been used on the Byrd polar flight in an engine of this type failed to flow to the pump at both test temperatures (−6° C. and −3° C.).

Properties of steam.—The equipment has been set up in the new quarters. The calorimeter was assembled, tested, auxiliary equipment consisting of thermocouples, resistance thermometers, thermostatically controlled baths, vacuum pumps, apparatus for electric measurements, and apparatus for purifying water, and for controlling and measuring the water was installed and the whole put into operation. Preliminary observations of the heat content of water up to 130° were made, and the technique of operation and measurement was developed. This work, which is in cooperation with the American Society of Mechanical Engineers, will yield data now badly needed on the properties of saturated steam at pressures up to 1,240 pounds per square inch, corresponding to a temperature of 300° C.

Heat transfer through air spaces and from surfaces in free air.—A critical review and correlation of the available data on these allied subjects was largely completed. This work is in cooperation with the heat transfer committee of the National Research Council in the effort to obtain practical working data of reasonable accuracy from the mass of rather discordant results to be found in the literature.

Heat transfer through building construction.—A large number of tests have been made on hollow frame wall construction under various conditions with various types of radiation shields within the air space. Tests were also made on panels of solid and of hollow brick construction. The results of these tests will permit calculation of the heat transfer through various types of walls without requiring a test on the completed wall.

Wind pressure on structures.—Because of large scale effects wind-tunnel measurements on models of tall chimneys can not be safely applied to full-scale structures. The bureau has decided to supplement wind-tunnel investigations by measurements on large cylinders in a natural wind. A cylindrical stack 10 feet in diameter and 30 feet high has been erected in an exposed position on the roof of one of the bureau's buildings. Measurements on the pressure distribution over this cylinder will be made during the coming year.

Superheatmeter.—This instrument, developed in cooperation with the Naval Bureau of Aeronautics, is used to measure directly the difference in temperature between the lifting gas in the cell of an airship and the outside air. The apparatus consists of a number of thermal elements in series, one set of junctions being in the gas cell and the other set exposed to air temperatures. A galvanometer, included directly in the circuit, is graduated to show directly the difference in temperature between the two sets of junctions.

Sphygmomanometers.—These instruments are used by physicians for the measurement of blood pressure. Two types are employed, in one of which an aneroid capsule is used and in the other some form of a mercury manometer. At the joint request of physicians and manufacturers an investigation of these instruments has been carried out in the course of which methods of testing were developed and tolerances established which appear to meet with general approval.

TESTING RAILROAD-TRACK AND OTHER SCALES ($39,000)

Railroad-track scales.—During the year tests were made of 840 railroad-track scales located in 35 States and the District of Columbia. The tests were conducted by three testing units operating over 73 railroad systems. Of the scales tested 465 were owned by railways, 364 by industries, 5 by States or municipalities, and 6 by departments of the Federal Government. Seventy-three scales were adjusted to correct excessive weighing errors.

An analysis of the test results shows that of all track scales tested 70.1 per cent were correct within the allowed tolerance. This represents an increase of approximately 5 per cent over the corresponding item for the preceding year and indicates a notable improvement in the accuracy of carload freight-weighing equipment. The average error for all scales tested was 0.21 per cent, a value which exceeds the tolerance limit by only 0.01 per cent.

Evidence of improved weighing conditions is most marked in the eastern district, where 75 per cent of the scales tested were within the tolerance, and the average error for all tested scales was only 0.16 per cent.

In the western district the beneficial effects of applying systematic maintenance measures to railroad-track scales are reflected in the figure of 77.8, representing the percentage of railroad-track scales found within tolerance.

Results for the southern district do not differ appreciably from those for last year, but advanced accuracy is expected to follow recent concentration of testing activity in that section.

Master track scales.—Fifteen master track scales were calibrated and found to be correct within the established tolerance. At the close of the year five master scales remain uncalibrated because of a shortage of operating funds. At this time cognizance should be taken of the fact that several master scales are now regularly called upon to standardize test cars weighing 100,000 pounds. The bureau is now without sufficient equipment to calibrate master scales to these capacities.

Railroad-track scales in grain-weighing service.—Of the 364 industry-owned track scales already discussed, 67 were used for weighing grain at mills and elevators. Of these, 26 scales, or 38.2 per cent, were found to be weighing within the special tolerance provided for this class of weighing service. Twenty-two scales found incorrect were adjusted to secure performances within the special tolerance. There is apparently no pronounced change in the general accuracy characteristic of grain scales during recent years. It is rather generally accepted that the current tolerances for this class of track scale are too stringent to be met by many scales used at mills and elevators.

Specifications.—Through representation on a subcommittee of the American Railway Engineering Association's yards and terminals committee the bureau during the past year cooperated actively in the preparation and promulgation of a code of specifications for two section track scales. These specifications have been formally approved and accepted by the American Railway Engineering Association and are shortly to be published by the bureau.

Test-car calibrations.—In connection with the field schedules of the track-scale testing units 32 track-scale test cars were calibrated for railroads and industries that were without master-scale facilities. Several new test cars of the type recommended by this bureau were placed in service the past year, of which approximately half were of 100,000 pounds standard weight. Casual survey of the calibration records finds the situation improved with respect to accuracy of test-car maintenance.

MASTER TRACK SCALE AND TEST CAR DEPOT ($50,000)

Donation of site for master track scale depot.—A site in clearing yard of the Belt Railway Co., of Chicago, just outside the city limits of Chicago, for the location of the master track scale depot, was donated in fee simple to the Government by the Chicago & Western Indiana Railroad Co., through arrangement with the General Managers' Association of Chicago. This splendid cooperation is very much appreciated. Plans for the building were completed and contracts were awarded for its construction and equipment. Excavation has commenced, and during the coming year the station should be put in operation. This station will calibrate the bureau's track scale testing equipments as well as those owned by railroads and operated throughout a very large region about Chicago, heavy weights, etc. It should be of tremendous help to the railroads and industries as well as to the bureau.

STANDARDIZATION OF EQUIPMENT ($115,000)

Adherence to simplified practice recommendations.—The outstanding development of the past year is the strengthening of support for and adherence to the simplified practice recommendations developed by various industries.

Recognizing that a relatively high degree of adherence makes any simplification program effective, cooperation has been extended to industries in perfecting a procedure, providing, among other things, for the appointment of a representative standing committee as a liaison service between the Department of Commerce and the industry concerned. This committee is charged with the duty of promoting, encouraging, and supporting the findings of the conferees, as well as conducting annual resurveys to ascertain the degree of adherence and to effect reaffirmations or any necessary revisions.

Annual audits or resurveys, conducted by the standing committees in 18 different fields, revealed that there is an average degree of adherence of 79.5 per cent. This indicates that the sizes, etc., adopted and published as simplified practice recommendations are being applied in the products themselves.

In many instances the data collected through the resurveys served not only to demonstrate the degree of adherence but also provided a basis for further eliminations or substitutions, thereby making it possible to keep the simplified practice recommendations up to date and in line with the best current practice of the industry concerned.

Individual commodities and the degree of adherence in percentage are detailed below.

(a) Degree of adherence obtained by actual survey

S. P. R. No.	Title of recommendation	Adherence	S. P. R. No.	Title of recommendation	Adherence
		Per cent			*Per cent*
1	Paving brick	79	20	Steel barrels and drums	84
2	Bedsteads, springs, and mattresses	51	24	Hospital beds	69
3	Metal lath	99	25	Hot water storage tanks	82
4	Asphalt	74	28	Sheet steel	53
7	Face and common brick	74	30	Terne plate	95
8	Range boilers	99	32	Concrete building units	98
9	Woven-wire fencing	97	36	Sand lime brick	62
12	Hollow building tile	84	46	Tissue paper	70
16	Lumber	80		Average	79.
19	Asbestos paper and millboard	82			

(b) Degree of adherence estimated by industrial leaders

S. P. R. No.	Title of recommendation	Adherence	S. P. R. No.	Title of recommendation	Adherence
		Per cent			*Per cent*
10	Milk bottles and bottle caps	75	31	Loaded paper shot shells	81
26	Steel reinforcing bars	85		Average	84.5
29	Eaves trough and conductor pipe	97			

Simplified practice recommendations accepted.—Up to the present time simplified practice recommendations have been accepted by manufacturers, distributers, and users of 62 commodities.

Recommendations in process of acceptance.—Simplified practice recommendations for 14 items have been proposed and approved at a general conference of manufacturers, distributers, and users and are now in process of acceptance by the various groups interested.

Field surveys in progress.—Surveys of existing varieties are in process for 37 industries.

General.—Seventeen general conferences of manufacturers, distributers, and users, resulting in the development and promulgation of 17 simplified practice recommendations, 48 preliminary conferences, and 29 revision conferences, resulting in the reaffirmation of 17 existing schedules and the revision of 12 recommendations, were held. Forty-four new fields requested cooperation in simplification programs.

A total of 898 acceptances of recommendations have been received from trade associations and other organized groups, as well as individual acceptances from 6,676 manufacturers, distributers, and users. Approximately 350,000 copies of simplified practice recommendations have been sold through the Government Printing Office. Judging from the number of foreign visitors and by the numerous requests received, there is a growing interest abroad in the simplification movement.

American Marine Standards Committee.—This committee is now composed of 324 member bodies, among which practically all phases

of the marine industry are represented. Technical activities are carried on by special committees, subject committees, and technical committees, comprising an aggregate personnel of about 270 members. The finished work so far accomplished consists of 47 standards which are being published as a series of the Department of Commerce.

Automobile headlight standards.—In addition to the testing of devices to determine whether they comply with the requirements of some of the States, the bureau has been called on to advise a number of State officials regarding the application of the uniform vehicle acts drawn up by the National Conference on Street and Highway Safety. It has also assisted in removing technical difficulties which have hindered the general use of the new types of headlights having controllable beams.

Safety standards.—Reports of the underwriters' laboratories on electrical devices were examined and advice given to State industrial commissions and local authorities on safety requirements. The bureau has assisted in revising the national electrical code of the National Fire Protection Association and in the preparation of final drafts of the lightning-protection code which has been under discussion for several years. Efforts have been continued to secure the general acceptance of a uniform code of colors for traffic signals.

Dry-cell standardization.—A complete new dry-cell testing equipment has been installed with a capacity of 4,000 batteries per year. Approximately 1,286 batteries from 20 manufacturers were included in the 1926 qualification tests made for the information of manufacturers and Government purchasing officers, and 1,240 batteries from 21 manufacturers have been started in the 1927 tests. New specifications for dry cells have been prepared and are now before the Federal Specifications Board and a sectional committee of the American Engineering Standards Committee for approval.

Radio standardization.—The bureau's representatives were active in the work of the American Engineering Standards Committee and the Institute of Radio Engineers in the standardization of radio-receiving sets and electron tubes. Special attention has been given to specific tube bases and tube terminology. The work on radio-receiving sets has led to the formulation of technical methods of measuring the most important characteristics of receiving sets.

Handbook on optical design.—The first of three parts of a handbook on optical design, intended to lead to standardized methods in the design of optical parts, has been published. This gives a complete treatment of the third order aberration equations, their method of application, and the general deductions regarding lens design which may be drawn from them. Detailed numerical examples are introduced in order to show clearly the method of using the equations and the great value of the results which may be obtained.

Facilitating the use of specifications.—Reference to work in connection with the "certification plan" and to the general work on specifications will be found under "General activities."

STANDARD MATERIALS ($10,000)

Distribution of standard samples.—Standard samples comprising ores, ceramic materials, metallurgical products, and pure chemicals

were distributed. They are used to check chemicals and methods of analysis that control the manufacture and sale of metallurgical and agricultural products, to calibrate instruments, such as pyrometers and combustion bombs, and to further research. A direct result of their use is a saving of thousands of dollars a year through improved manufacturing operations and the avoidance of litigations based on faulty analysis.

INVESTIGATION OF RADIOACTIVE SUBSTANCES ($9,540)

Investigation of RaE.—The correct value of the half period of RaE, one of the products in the radium disintegration series, has recently been the subject of some dispute in scientific circles. Therefore observations have been made on the rate of decay of several different preparations of RaE. The result of this investigation favors the earlier value of the half period; namely, 5 days, as contrasted with the currently accepted value of 4.85 days. The figures obtained for the different preparations range from 4.96 to 5.07.

Tests of radium preparations.—Over $500,000 worth of radium preparations were tested. These tests determine the sale price of the preparations and prevent disputes.

INVESTIGATION OF AUTOMOTIVE ENGINES ($25,000)

Survey of methods of measuring antiknock characteristics of fuels.—This project, which forms part of the cooperative fuel research program, is extremely important because of the present general interest in antiknock motor fuels and the lack of any accepted standard method of rating fuels on the basis of their antiknock characteristics. The recent action of the State of North Dakota, where a law was passed requiring that red antiknock gasolines must show "antiknock characteristics equal to a blend of 25 per cent benzol and 75 per cent straight-run gasoline from typical mid-continent crude oil or its equivalent," and stating that "the method used to determine whether a gasoline meets this requirement shall be the one adopted by the United States Bureau of Standards or recognized by said bureau as being the most satisfactory," has called attention to the fact that no entirely satisfactory method of rating antiknock motor fuels is yet available.

Starting of internal-combustion engines.—The engine-starting tests previously made on a four-cylinder truck engine were supplemented by tests on a six-cylinder passenger-car engine, and it was found that the starting performance of both engines on a given fuel was practically identical. A careful analysis of the engine tests on various fuels and of the volatility data on the same fuels led to the conclusion that the fuel requirements for engine starting could be specified in terms of the usual distillation curve of the American Society for Testing Materials.

Phenomena of combustion.—During the year further data were obtained on the velocities of explosive reactions at pressures less than atmospheric.

That reaction velocity is proportional to the molecular concentrations of the reacting gases has been verified for known mixtures of (1) carbon monoxide and methane with oxygen and (2) carbon

monoxide and hydrogen with oxygen. The effect of inert gases (nitrogen, helium, or carbon dioxide) on the carbon monoxide-oxygen reaction and on the methane-oxygen reaction has also been studied. These results are of great interest and importance to the mining and other industries.

Economic volatility of motor fuels.—The investigation of motor fuels with particular reference to their performance in automobile engines has been carried on for five years in cooperation with the American Petroleum Institute, the National Automobile Chamber of Commerce, and the Society of Automotive Engineers. During the past year the conclusions already reached have been published.

Recommendations in regard to the purchasing of oils by the Federal Government.—Evidence has been collected showing that in many instances unsatisfactory performance of oils has resulted simply from the selection of an oil of too high or too low viscosity. To remedy this, a "recommendation chart" has been prepared for Federal purchasing agents, indicating what grade (that is, viscosity) of motor oil is most suitable for use in the numerous different makes of passenger cars, trucks, and tractors.

Cooperative investigation of lubricants for artillery automotive equipment.—The bureau has cooperated with the Quartermaster Department of the Army in the examination of both new and used oils and in preparing a critical analysis of service tests of lubricants in artillery tractors at the Aberdeen Proving Ground.

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 was approved in May by the American Engineering Standards Committee.

Automotive headlighting.—The bureau is cooperating with the Society of Automotive Engineers and the Illuminating Engineering Society in research work on the headlighting problem. Two test cars have been provided with sets of special equipment designed for testing on the road various headlighting combinations from the automobile driver's point of view, with the object of increasing the safety of night driving.

TRANSFERRED FUNDS ($295,000)

Organization and projects—During the year funds were transferred from the following branches of the Government covering the projects listed:

Aeronautics Branch, Department of Commerce: Radio research, with special reference to radio in aeronautics.
Bureau of Engraving and Printing:
- Increasing durability of paper currency.
- Chromium plating of printing plates.

Bureau of Foreign and Domestic Commerce: Directory of commodity specifications.
Bureau of Mines: Petroleum research and testing.
Coast and Geodetic Survey: Special castings.
National Advisory Committee for Aeronautics:
- Aerodynamical research.
- Substitute for parachute silk.
- Fatigue and embrittlement of duralumin.

Navy Department:
- Rope and cordage.
- Storage batteries.
- General aeronautic power-plant problems.
- Gas-cell fabrics for dirigibles.
- Substitute for parachute silk.
- Corrosion of duralumin.
- Automatic mixture control for aircraft engines.
- Radiobeacons.
- Airship girders.
- Airplane carburetors.
- Making of optical glass.

Shipping Board: Miscellaneous problems in physics, chemistry, metallurgy, and engineering.

War Department:
- Bomb ballistics.
- General automotive problems.
- Rope and cordage.
- Embrittlement of duralumin.
- Machine guns.
- Tests of aircraft engines in altitude laboratory.
- Sound tracking.
- Helium indicators.
- Precision gauges.

Many of these projects were supported partly by bureau and partly by transferred funds. The more important of these have already been described under the appropriate bureau fund.

Important accomplishments supported wholly by transferred funds include the following:

Aircraft in commerce.—The aeronautics branch of the Department of Commerce designated the Bureau of Standards as its research unit and gave special emphasis to research on the use of radio. Progress has been made in developing practical devices to serve as radio aids to air traffic. These devices include the directive radiobeacon, a system of marker beacons, and radiotelephony from ground stations to aircraft. The directive beacon was originally developed by this bureau in 1921 for the War Department, was further improved in subsequent years by that department, and has now undergone some additional development. This beacon sends out a directive type of radiation by means of which the aviator can follow a set course. The marker beacons are low-power radio transmitting outfits which are to be placed on the emergency landing fields and serve as milestones to indicate how far flight has progressed along the course marked out by the directive radiobeacon. The most immediately needed of these radio aids to air navigation is radiotelephony. By means of fixed ground stations it is expected that the Department of Commerce will be able to broadcast important weather information to airplanes in flight, and thus facilitate landing and navigation. The experimental work on radiotelephone included the connection of two-way conversations between airplane and ground to the regular telephone exchange, permitting conversations between persons at the ordinary desk telephones and other persons on airplanes in flight.

Aerodynamical characteristics of airfoils at high speeds.—A study of the aerodynamical characteristics of 21 airfoil sections at speeds up to and slightly above the speed of sound, made in cooperation with the National Advisory Committee for Aeronautics, indicates that the efficiency of any particular section is dependent upon the

speed employed. In order to secure maximum efficiencies in propellers, for example, the section should be modified near the tips of the blades by moving the maximum thickness of the section back toward the trailing edge. All sections which have been tested show decreased efficiency at the higher speeds which is associated with the change in the character of the flow around the airfoil.

Airship girders.—In cooperation with the Bureau of Aeronautics, Navy Department, investigation has been made of the deformation of the longitudinal elements of triangular and square girders. In the case of a girder 5 feet long, with longitudinal members of sheet duralumin formed into a channel section, it was found that the ultimate strength of the material could not be developed because the longitudinal members deformed by twisting about their longitudinal axes. By restraining this twist the strength of the girder was considerably increased. Probably girders with tubular longitudinals can be designed which will not fail before the compressive yield point of the material is reached. The strength of the girder would be increased about 50 per cent without increasing the weight, an important consideration in designing the structural framework of rigid dirigibles.

Strength of tubes.—In cooperation with the Bureau of Aeronautics, Navy Department, the strength of tubes of duralumin and alloy steel when used as columns or beams has been investigated. The work included determination of the strength of the tubes under axial compressive loads, transverse loads applied at the third points, and combinations of axial and transverse loading. An investigation of duralumin tubes 1.5 inches in diameter has been completed, and work is in progress on the remainder of the program.

Prevention of embrittlement of duralumin.—Duralumin is subject to intercrystalline corrosion resulting in embrittlement. The bureau has found that this corrosion is markedly reduced by rapid quenching in cold water during heat treatment, instead of in hot water or oil. Pure aluminum is not susceptible to this type of corrosion, and laboratory tests, supported by a year's exposure tests, indicate that a coating of pure aluminum effectively protects duralumin from intercrystalline attack. The method is now being used commercially. This work was supported by the War and Navy Departments and by the National Advisory Committee for Aeronautics.

Substitute for goldbeater's skin.—An important investigation on substitutes for goldbeater's skin for gas bags of dirigibles for the Navy Department was carried to the point at which experimental fabrics were made in a commercial coating plant instead of in pieces a yard square in the laboratory. Fabrics so made will be tried under service conditions. Many tests of permeability of airship fabrics to hydrogen were made.

Helium purity indicators.—Three helium purity indicators for airships were constructed, in addition to a special indicator capable of determining the purity of helium at four different points in the ship.

Supercharging of aircraft engines.—Tests have been made on a Curtiss D-12 engine and a Liberty 12 engine under ideal supercharging conditions; that is, with air supplied to the carburetor at sea-

level pressure while the pressure at the exhaust ports is reduced to the standard pressure corresponding to any desired altitude.

At the request of the Army Air Corps tests have been made of a Curtiss D–12 engine equipped with a gear-driven centrifugal supercharger installed between the carburetor and the intake manifold. This supercharger is designed for low altitude work and, for an engine speed of 2,000 r. p. m., its critical altitude is about 7,500 feet.

Chromium plating.—As a result of further studies of chromium plating the process at the Bureau of Engraving and Printing has been improved, and its use there has been extended to include both currency and stamp plates, with increased savings. The process is about to be installed at the Philadelphia Mint for plating dies, collars, and placques. Tests indicate that this will improve the quality and decrease the cost of coinage. Experiments have also been made with promising results on specific applications of chromium plating for the War Department, Coast and Geodetic Survey, and National Advisory Committee for Aeronautics.

Motor vehicle rating.—This investigation, undertaken several years ago at the request of the State of Connecticut, had as its object the development of an equitable basis of rating motor vehicles for purposes of taxation. The particular problem has been solved in a manner simple enough to allow of economical administration, and a final report has been made.

GENERAL RECOMMENDATIONS

Research on standards.—A substantial increase in the salaries fund is urgently needed. This appropriation is used in the administrative and operative work of the bureau and also in carrying out certain of the functions enumerated in the organic act which are not otherwise provided for by Congress. These include the custody, comparison, and construction of standards used in scientific investigations, the determination of constants in physics, chemistry, technology and engineering, and the testing of standard measuring apparatus—all necessitating fundamental research. The importance of this work can not be too strongly emphasized. Additional assistance is needed to bring it more nearly current, as some of the basic standards have not been adequately checked for years. The visiting committee is strongly in favor of making more adequate provision for these fundamental functions to meet the ever-growing demands of the country for these services.

Development of commercial standards.—It is highly desirable to increase and consolidate our activities relating to standards used in commerce and industry by the formation of a division of commercial standards, extension to the commercial specification field of the cooperative methods of the division of simplified practice, and making more readily available to industry the results of the work of the Federal Specifications Board. A second assistant director should be placed in charge of this work, which is of the greatest economic importance to the country.

Consolidation of funds.—The 28 appropriations under which the bureau now operate necessitate the maintaining of records by the

accounting, auditing, and disbursing officials that could in part be dispensed with if the funds were consolidated. It is believed the appropriations of the bureau could be grouped into three or four classes, carrying the present items as subappropriations, without loss of administrative control of the various activities. This would permit the simplification of office procedure and eliminate technicalities that are occasioned by a multiplicity of funds.

New heating and power plant.—This summer actual construction work on the building will be started which it is expected will be completed next spring. Funds should be provided to cover the purchase and installation of the necessary operating equipment, amounting to $300,000, of which one-third will be needed in each of the fiscal years 1928, 1929, and 1930.

Hydraulic laboratory.—I urgently recommend that authorization from Congress be obtained and funds be granted for the building and equipping of an hydraulic laboratory at the bureau. The functions of this laboratory would be to test hydraulic instruments and accessories, to study the behavior of moving water and the design of hydraulic structures, and to determine the fundamental data useful in hydraulic research and engineering, including problems relating to river and tide flow in various types of channels.

This is a most important field, and there are awaiting solution many fundamental problems which can only be attacked in a laboratory specially equipped for hydraulic research. At present there is no laboratory of this type in the country, while there are some 8 or 10 in Europe, where they have been found of the greatest use in the economical solution of complicated engineering problems involving flow of masses of water. In one European laboratory it is reported that the construction savings effected by each major problem there solved have paid the cost of the laboratory.

Such a laboratory would cost $200,000, with $50,000 a year for upkeep, and the several field services of the Government dealing with problems of water flow would benefit greatly.

Need for increased facilities at branch laboratories.—In order to take care of the many requests from governmental agencies for the testing of structural materials the bureau maintains three branch laboratories, located at Northampton, Pa.; Denver, Colo.; and San Francisco, Calif.

The work of the Northampton laboratory is exclusively cement testing, and as it is situated in the Lehigh Valley cement-producing district it supervises the major portion of Government orders for Bureau of Standards tested cement. The Denver laboratory cares for the cement testing of the territory between the Mississippi River and the Rocky Mountains. Besides its cement-testing work, many studies are made of the suitability of local aggregates for use in concrete structures for the Reclamation Service. The San Francisco laboratory cares for the cement testing on the west coast, which includes many shipments to the Hawaiian Islands, and also cares for many tests of miscellaneous materials used in construction work.

At the present time, with the large amount of work undertaken by the Government in various parts of the country, these branch laboratories are caring for a volume of work which prohibits further demands unless the personnel and equipment can be increased. With

the demand of purchasing agents that materials meet the requirements of the specifications of the Federal Specifications Board this commodity testing work will continue to increase, and it is in the interest of economy to make adequate provision for it.

Medical aid.—I again recommend that provision be made for the establishment at the bureau of a first-aid station in care of a competent physician preferably detailed from the Public Health Service. Such a station is an imperative need at an institution of the type of the bureau, where there are so many accident hazards. Also, there are several lines of work, including radium, X-ray and furnace operations, requiring medical oversight of the physical condition of the operating personnel.

Very truly yours,

GEORGE K. BURGESS,
Director, Bureau of Standards.

BUREAU OF FISHERIES

DEPARTMENT OF COMMERCE,
BUREAU OF FISHERIES,
Washington, July 1, 1927.

HON. HERBERT HOOVER,
Secretary of Commerce.

DEAR MR. SECRETARY: I have the honor to submit the following summary of the major operations of the Bureau of Fisheries during the fiscal year ended June 30, 1927.

Perhaps the most noteworthy development of the year has been the growing appreciation of and expressed need for expansion of modern scientific research in the solution of fishery problems. This is shared by men in the fishery industries confronted by the many problems in the taking, merchandising, and distribution of fish and fishery products; by State and other officials interested in determining the condition and trend of each fishery and the need for and character of regulations necessary for the husbanding and wise use of our fishery resources; by Federal, State, and private agencies confronted with problems of large-scale fish propagation, the prevention of losses by fish diseases, and the development of the science of aquiculture; and by the thousands of organizations and individuals interested in having good fishing and enjoying the use of lakes and streams for recreational pursuits. It is believed that the bureau's present program of practical research and applied science is accomplishing much in inspiring confidence in and dependence on modern science for the solution of problems in fish culture, fishery administration, and technology. This also applies to the important duty of regulating and conserving the highly valuable fisheries of Alaska.

The concern felt for the future of such fisheries as those for shad, sturgeon, whitefishes, and lobsters, and the appreciation of the value of scientific research as a basis for wise administration of fishery resources, has caused demands to be made wholly beyond the scope of the scientific staff to cope with; and the same is true of demands for assistance from the bureau's technological staff in solving the problems of the commercial fishermen.

The bureau produced 6,481,073,000 fish and eggs for stocking various waters, an increase of more than 1,000,000,000 over the preceding year and the greatest production in the history of the bureau. Fifty-five cooperative fish nurseries assisted in rearing more fish from the fry stage to a length of 3 or 4 inches. Greater cooperation with State commissions helped to make this an unusually successful year; nevertheless present facilities are wholly inadequate for meeting the increasing demand for the trouts, basses, and sunfishes.

In 1926 the fishery industries experienced one of the most successful years in their history. The vessel landings at New England ports, which averaged about 170,000,000 pounds for the five-year period—1920 to 1924—had increased to nearly 217,000,000 pounds in 1925 and made a further increase to over 238,000,000 pounds in 1926. In large measure this growth is due to the growing demand for fish packed as fillets and steaks and to the unusually large catches of mackerel, which in 1926 exceeded 60,000,000 pounds. Landings of haddock (the principal fish sold in package form) averaged 73,000,000 pounds for the five-year period—1920 to 1924—increasing to nearly 92,000,000 pounds in 1925 and to more than 94,000,000 pounds in 1926.

A record pack of salmon was canned in Alaska, amounting to 319,000,000 pounds, valued at $46,000,000, representing an increase of 105,000,000 pounds as compared with 1925. In California the production of canned sardines was the largest in the history of that industry, amounting to over 100,000,000 pounds, valued at $7,807,000. The total pack of salmon was 359,450,000 pounds, valued at $56,219,000; of canned sardines in Maine and California, 143,415,000 pounds, valued at nearly $14,535,000; and the total value of canned fishery products and fishery by-products approximated $100,000,000. Our annual fishery harvest now exceeds 3,000,000,000 pounds, valued at $109,000,000 to the fishermen.

Highly efficient service on the part of the bureau's personnel has made possible the record of achievements given in this report.

INTERNATIONAL RELATIONS

NORTHERN PACIFIC HALIBUT CONVENTION

Under the terms of the convention with Great Britain, ratified October 21, 1924, provision is made for an international fisheries commission, whose duty it is to have made a thorough investigation into the life history of the Pacific halibut and to make recommendations as to what regulations are deemed necessary for the preservation and development of this fishery. The scientific staff, under the able direction of Will F. Thompson, has vigorously prosecuted the work and completed the first phase of it, which relates to the development of means and methods of research, the crystallization of plans of procedure, and beginning the active prosecution of such work. A preliminary report has been made to the commission.

A thorough statistical study has been made of market landings and fishermen's logs. From the pilot-house logs of the fishing vessels a record has been obtained of the vessels' movements, the amount of gear fished day by day, the locality of capture, and the estimated weight of the fish taken. For 1926, records were taken for nearly 260,000 units of gear, which took 19,400,000 pounds of halibut, or 35 per cent of the total Pacific coast catch. These records indicate a shifting of the center of fishing operations from Hecate Strait in 1910 to Portlock Bank in 1926. The log records also are valuable as a measure of abundance of the fish supply and the rate of decline of the catch. In Hecate Strait, for example, the catch of fish per skate of gear in 1906 was 450 pounds, declining to 143 pounds in 1914 and 47 pounds in 1926. The evidence is plain that the southern and older fishing banks are becoming steadily less productive and that the proportionate number of smaller fish in the catch is increasing.

Nearly 9,000 halibut have been tagged. Of the fish tagged on the southern banks in 1925 and 1926, about 16 per cent have been recovered. The migrations on these banks appear small, the average extent of movement being less than 20 miles. The evidence indicates that the immature fish do not migrate to any extent. On the offshore banks of the Gulf of Alaska and on the Aleutians, where the fish are more mature, indications are that the mature fish become more migratory. Thirty-three fish recovered from nearly 1,800 fish released averaged 275 miles, with 865 miles as the maximum. This enables us to get an idea of the exceeding complexity of the problem and the need for painstaking research to establish the facts.

The scientific staff has collected a fund of information along biological lines, which later will be found to be of great use when there has been opportunity to work over it thoroughly. This includes racial measurements, rates of growth, study of the eggs and larvæ of the halibut and their drift with the currents, and effectiveness of large and small gear and their effect on the fishery. The biological results fully corroborate the results obtained from tagging, as far as migration is concerned, but, of course, present many other facts. Intensive laboratory work must follow to bring out these facts.

On February 23, 1927, the fishing schooner *Scandia*, under charter by the commission, was hurled onto a reef half a mile off Kodiak Island, in the midst of a high sea and a blinding snowstorm, and wrecked. Through the prompt and courageous action of the captain and crew of the seine boat *Duncan I*, the scientific staff and crew of 15 men were saved, but the equipment and gear were lost. The loss of the *Scandia* was the climax of an exceedingly hard winter, during which the halibut investigations had been conducted with great difficulty, much of the work having been done virtually in intervals between storms. The catch of Pacific halibut (United States and Canada) in 1926 was 53,780,389 pounds, as compared with 49,843,967 pounds in 1925, an increase due to more intensive fishing.

FISHERIES CONVENTION WITH MEXICO

The convention between the United States and Mexico to prevent smuggling, and for certain other objects, which was ratified on March 18, 1926, contained a section devoted to the fisheries, quoted in full in the last annual report. Upon the initiative of the United States Government, the convention was terminated on March 28, 1927, or at the end of a year after it came into effect. During the life of the International Fisheries Commission, provided for under the terms of the treaty, a program of scientific investigations was drafted and preliminary investigations were begun.

A study of the record of the California Fish and Game Commission with respect to the receipts of fish from waters off the coast of Mexico, 1920–1925, inclusive, disclosed that of the total landings of the catch from the waters off both coasts at California ports the following percentages came from waters off the coast of Mexico: Yellowfin tuna, 79; spiny lobster, 70; black sea bass, 48; barracuda, 33; skipjack, 33; white sea bass, 26; bonito, 25; and yellowtail, 21. The investigative program, therefore, was to concern mainly these species.

Statistics of the fish, mollusks, and crustaceans landed in California during the calendar year 1926, as reported by the California Fish and Game Commission, show 371,648,275 pounds, of which 23,058,741 pounds were taken in Mexican waters. During the year about 750 American fishing boats operated off the coast of Lower California, Mexico, with 11 vessels, of 75 to 100 tons each, acting as tenders, and 4 or 5 barges. The investment of American capital in boats, fishing gear, and cannery capacity dependent upon the Mexican supply of fish is estimated at $10,000,000, exclusive of the investment in fresh-fish markets.

Although most of the fish of the Mexican coast are caught outside the 3-mile limit, it is necessary for the boats to enter Mexican territorial waters for shelter and to take sardines and other small varieties used in the live-bait operations. Also, the safest and most direct course for home brings the boats within 3 miles of the shore and under Mexico's jurisdiction. Therefore it is necessary for American fishermen to clear for Mexico rather than for the "high seas," to take out Mexican fishing permits, and pay the export fees on dutiable fish in observance of that country's regulations.

When the canneries and fresh-fish markets of the United States first began to draw upon the marine life off the coasts of Mexico, that country considered this resource of relatively little importance. Difficulties arose in the administration of fishery affairs, unfortunate practices crept in, and general dissatisfaction with existing conditions increased. When these matters were brought to the attention of the central Government, interest was aroused in the fisheries. More stringent regulations were put into effect, and higher rates of duty were imposed. It was this unsettled state of affairs that led Mexico to propose the fisheries section to the convention under discussion.

The abrogation of the convention came before the constructive program planned could accomplish any real benefits. There is urgent need for the adoption of a program of conservation that will insure the perpetuation of this important resource. This must be preceded by scientific studies to disclose the condition and trend of each fishery as a basis for the adoption of regulatory measures. There is also need for an impartial agency to prevent dissension and to promote harmonious working agreements between the two countries in the handling of fishery matters.[1]

NORTH AMERICAN COMMITTEE ON FISHERY INVESTIGATION

This committee, composed of delegates from Canada, Newfoundland, and the United States, held two meetings during the year—one at St. Johns, Newfoundland, on July 9, 1926, and the other at Washington, D. C., on April 28, 1927.

The fisheries statistics of the various countries that fish the banks of the northwestern Atlantic are being correlated so as to make it possible to follow the entire fishery of the banks of that region. A summary of the total annual catches of cod of the region taken by Newfoundland, France, Portugal, Canada, and the United States during the past 40 years or more shows that the cod fishery has furnished about 1,000,000,000 pounds of fish annually, ranging from 850,000,000 to 1,350,000,000 pounds. Although there have been con-

[1] Based on a report by Miss Geraldine Conner, American secretary.

siderable fluctuations, these have been upward as much as downward, so that there is no evidence of any definite decline in the fishery or of any depletion of the stock.

Studies of the cod off the coast of the United States reveal that fish that live off Cape Cod in the summer migrate to the New Jersey coast during the winter and return in the spring. Fish tagged at Mount Desert, Me., have been found to move chiefly eastward to both coasts of Nova Scotia, only an occasional one moving westward and reaching as far as Cape Cod.

Growth studies of the cod in Canadian waters indicate that the scales do not grow in the same degree as the fish throughout the year, but grow relatively more rapidly at one time and relatively less rapidly at another. Of 275 cod tagged off Halifax, Nova Scotia, in 1925, and 3,747 off Shelburne, Nova Scotia, in 1926, more of the former lot were recaptured in the following year than during the year in which they were tagged, being retaken only along the coast and at no great distance, but going more to the southwestward (nearly to Liverpool, Nova Scotia) in the second year. The Shelburne cod showed very little movement, and that chiefly to the eastward, going as far as Liverpool, Nova Scotia, during the season, but reaching farther eastward (to Halifax) during the succeeding winter.

Investigations of the haddock of the Canadian coast reveal that the haddock population of the Bay of Fundy, particularly of the New Brunswick shore, failed to receive any considerable number of young for a series of years, with a resultant decline in the fishery. Then the young came in suddenly, and in a year or two the fishery greatly increased and has continued at a high level.

The haddock grows more rapidly in the early years of its life in the warm water of Passamaquoddy Bay, New Brunswick, than in the cold water on the outer coast of Nova Scotia near Lockeport; but this rapid growth falls off in later years in the warm water more than in the cold. The rapid growth of the year is limited to the months August to October. In 1926 2,540 haddock were tagged near Shelburne, Nova Scotia. They showed very little movement southwestward along the coast but considerable movement northeastward, as far as Halifax and Sable Island Bank—twice as far as the cod tagged simultaneously with the haddock.

The Canadian investigations of the mackerel have shown that it spawns in negligible amount in the Bay of Fundy and without success in producing fry, and on the outer coast of Nova Scotia the eggs fail to develop into fry. In the Gulf of St. Lawrence, however, spawning is extensive and very successful. Late in the summer the fry are to be found passing out of the gulf, around Cape Breton Island. The eggs have been found to require warm water for successful development. Studies of the mackerel of the Canadian coast reveal evidence of differences between those of southwestern Nova Scotia and those of the Gulf of St. Lawrence. In 1925 and 1926, in Canadian waters, 2,382 mackerel were tagged. The returns from those tagged at Yarmouth show a movement northeastward to the Gut of Canso, northward into the Bay of Fundy, and westward to the coast of Maine. Fish tagged at the Magdalen Islands in 1925 showed a movement to Prince Edward Island in the same season, and in the next year some of them returned to the coast near Halifax and in Massachusetts.

Mackerel tagged in 1925 at various points from Buzzards Bay, Mass., to Casco Bay, Me., spread in both directions along the coast from the point of tagging but did not migrate far. In the following year those recaptured were taken on the whole to the southwest, along the coast from where they had been tagged the previous year, one tagged on the coast of Maine being taken at Fire Island, N. Y. One of the mackerel tagged off Delaware and Maryland in 1926 was recaptured several months later near Cape Cod.

GREAT LAKES FISHERIES

The evidence at hand clearly indicates a decline in the Great Lakes fisheries, so marked as to cause grave concern for the future of these fisheries. The very existence is threatened of the bluefin in Lake Superior, the blackfin in Lake Michigan, the bloater in Lake Ontario, and the sturgeon in all the lakes. In less than half a century the catch of whitefish has declined from 21,000,000 to 4,000,000 pounds, and the sturgeon from 7,500,000 pounds to less than 100,000 pounds per annum. The aggregate catch has been maintained at a fairly fixed level by the substitution of more rough fish as the supply of the choicer species declined, and by greatly increasing the number and effectiveness of the units of gear employed.

The problem of fisheries administration is a most difficult one, in view of the fact that jurisdiction is divided between eight States and a Canadian Province. The questions are not alone State, but national and international. Jurisdiction over Lake Michigan is divided between four States; that over Lake Erie between four States and the Province of Ontario. There is a growing appreciation of the need for a better understanding of the problems and of better laws and their enforcement. Under such a division of authority it is difficult to get concerted action.

At the invitation of the Governor of Ohio to representatives of the States bordering Lake Erie, the Province of Ontario, and this bureau, a conference was held at Columbus, Ohio, on February 16, 1927. The purpose of the conference was to attempt to secure coordinated action in conserving the fisheries of Lake Erie. Resolutions were adopted, which, if enacted into law, would afford greater protection to the fisheries. Subsequent progress toward the enactment of such measures holds forth little hope of immediate action to meet the serious situation that exists.

At the call of the Governor of Michigan on March 3, 1927, at Lansing, a conference of fishery officials from the States bordering the Great Lakes and from the bureau was held to consider ways and means for conserving the Great Lakes fisheries. Only measures of general application to all the lakes were considered, and proposals with respect to fishing gear, sizes of fish, and the taking of spawn were made by the several States and the Province of Ontario.

UPPER MISSISSIPPI RIVER WILD LIFE AND FISH REFUGE ACT

Regulations for the administration of the upper Mississippi River wild life and fish refuge act of June 7, 1924, were signed and issued jointly on June 24, 1927, by the Secretary of Agriculture and the Secretary of Commerce. These regulations prescribe the conditions under which hunting, fishing, and other recreational activities will be permitted. Areas of overflowed bottom lands along the Missis-

sippi in the States of Illinois, Iowa, Wisconsin, and Minnesota, from Rock Island, Ill., to Wabasha, Minn., are being acquired by the Department of Agriculture as rapidly as possible.

There are many sloughs and bayous within the limits of the reservation, some of which are navigable to boats of light draft, which may be utilized for growing fishes for restocking streams, and to be inoculated with the glochidia of the fresh-water mussels, thus helping to perpetuate this important industry.

PROPAGATION AND DISTRIBUTION OF FOOD FISHES

The fish-cultural operations of the bureau present a picture of yearly production being increased to meet a constantly growing demand. The increase in the number of applications received has been greater than the increase in facilities for production.

During the past year no new hatcheries have been put in operation, so that the larger output has been brought about by redoubling efforts to utilize present facilities to their utmost capacity. The general conviction that fish 3 or 4 inches long or larger are essential for the successful repopulation of our waters has resulted in an intensive effort to produce more fish of this class. The output of commercial food fishes has been increased materially, particularly on the Atlantic coast.

COOPERATIVE FISH-CULTURAL WORK

The older conception of the division of fish culture as an agency for delivering so many fish upon order, as if this were a manufactured product the ultimate disposition of which was of little interest to the manufacturer, is disappearing. The real task is to restock the waters, and cooperative efforts are doing much to accomplish this.

The outstanding work along this line has been the cooperation with the sportsmen's clubs, which have received fry for rearing to fingerling size. Fifty-five of these nurseries are in operation, the majority in Pennsylvania and Wisconsin. Many more are awaiting completion of arrangements or are under consideration. In many cases the clubs are holding the fish received in the spring of 1926 for liberation this autumn at an age of 18 months. A new project has been undertaken this year, which exceeds in magnitude the leading nursery projects of last year. The Utica chapter of the Izaak Walton League of America has taken over a discontinued commercial hatchery at Barneveld, N. Y., which the bureau is operating. An initial stock of over 200,000 young fish has been supplied, and the project will be conducted so as to produce eggs from a brood stock of adult fish.

The bureau also has furnished advice to individuals and clubs desirous of raising fish individually. Further cooperation has been effected by the utilization of privately owned or controlled waters as egg-collecting stations. The bureau's employees take eggs from bodies of water in which a stock of fish has become established, the owner receiving a sufficient quantity to maintain the stock. A number of lakes in Colorado have yielded a fair quantity of rainbow and brook trout eggs under such arrangements.

An output of 6,481,073,000 fish and eggs represents the greatest production in any year since the bureau began its fish-cultural activities. Increased collections of four marine species—cod, haddock, pollock, and winter flounder—are largely responsible for the increase

of over 1,000,000,000 more than the figures of last year. Large yields were obtained in some of the other classes, including an appreciable increase in the output of game species. The failure to equal the records of past years in the production of fingerlings is due to a shortage in one of the important groups—the Pacific salmons—and to limited collections from the Mississippi River. Inasmuch as all fish from the latter source are of fingerling size, limited collections make themselves evident in this class.

As an indication of the relative proportions of the various classes of fishes of this total, it may be pointed out that it included 5,473,378,000 fry and eggs of commercial marine species, 120,213,000 of the commercially important Pacific salmons, 548,535,000 of the commercial species of interior waters, and 247,313,000 of the anadromous forms, also of commercial significance. The game fishes were represented by 51,523,000 trout and salmon and 36,222,000 of the warm-water pond species.

RELATIONS WITH STATES AND FOREIGN GOVERNMENTS

Cooperation with the various States has been an important part of the bureau's fish-cultural work. The bureau has been of assistance by furnishing the advice and supervision of its experienced employees, by assigning eggs and fry to the States, and by assisting in the collection of eggs. The States have reciprocated by permitting the collection of adult brood fish, allotting funds for carrying on work of joint benefit, and by assisting in the distribution of fish. The Bureau of Fisheries and the States of Vermont and Pennsylvania operated the Swanton (Vt.) pike-perch station jointly. Over 1,000,000 trout eggs were incubated for the State of West Virginia at the White Sulphur Springs (W. Va.) station. Similar relations have been maintained with the State of South Dakota. The propagation of buffalo fish in conjunction with the State of Louisiana was undertaken. The bureau furnished the services of a man for shad propagation undertaken by the State of New Jersey. Extensive cooperative work has been initiated in Arkansas, where suitable areas have been taken over as nurseries for bass and other pond fish. Ponds have been stocked, and a number of others are being prepared for this purpose.

A total of 84,586,000 eggs was furnished to 24 States during 1927. The pike perch, yellow perch, whitefish, and cisco comprised 61,900,000 of this number, while the remainder consisted of various species of trout and salmon.

Arrangements have been perfected with the United States Forest Service whereby improved distribution practices will be followed and rearing ponds established. Generous allotments of fish and eggs have been made for stocking waters in the forest areas, notably in Wyoming and in the Sawtooth National Forest in Idaho. Inspections have been made of pond sites in the Ouachita National Forest and the Unaka National Forest.

Requests for the shipment of eggs of various species to foreign governments have been complied with as far as possible. This included the distribution of 2,227,000 eggs and 19,500 fish to five countries, Canada, Costa Rica, Italy, and Switzerland receiving rainbow trout, while Japan was assigned rainbow trout and whitefish.

PROPAGATION OF PACIFIC SALMONS

The work in the Pacific States and Alaska has been marked by improvements at certain points. It has been the rule to hold a maximum number of fingerlings at each station throughout the season, planting when for lack of space it has been absolutely essential to dispose of some of the stock.

Light has been thrown on the problem of power dams in salmon streams by a study of the operation of a fish ladder in the Baker River near Concrete, Wash. The dam, over 200 feet high, has a fish ladder of the common Cail type, together with a mechanical elevator for hoisting cars of fish over the crest. As a result of practical experiments it is expected that the science of developing a satisfactory fishway will be advanced materially.

In Alaska continued destruction of predatory trout has resulted beneficially in the vicinity of Afognak and Yes Bay. At the Yes Bay (Alaska) station the fingerlings have been placed in feeding ponds, from which they are permitted to work out gradually. It is believed that they become better adapted to conditions in natural waters in this way than by a sharp transition from the hatchery to the lake. Not until the entire hatch of salmon fry can be reared to fingerling size will the maximum benefit be attained from these fish-cultural operations.

MARINE SPECIES OF THE NORTH ATLANTIC COAST

Operation of the bureau's marine stations at Woods Hole and Gloucester, Mass., is contingent upon commercial fishing operations in the vicinity. Cod, haddock, and pollock eggs are taken largely by spawn takers on the fishing vessels. Only a small percentage of the eggs is obtained by independent spawn-taking operations conducted by the bureau. A substantial increase over the previous season's figures for this work resulted. Minute variations in the water, particularly in its specific gravity, affected the success of artificial incubation, and in such cases it has been found necessary to plant the fertilized eggs on the fishing grounds. Concomitant with the augmented market utilization of haddock, the number of eggs of this species handled by the bureau has been more than doubled. The hatching of winter-flounder eggs has been centered largely at the Boothbay Harbor (Me.) station, and the collection has been increased by about 800,000,000 over that of last year. The station makes its own collection of brood fish, operating in near-by waters. For the first time in a number of years the Boothbay Harbor station has handled cod eggs. As difficulty was encountered in incubating the eggs at the hatchery, the majority were fertilized and planted on the adjacent spawning grounds.

ANADROMOUS FISHES OF THE ATLANTIC COAST

This work comprises the hatching of shad, river herring, and Atlantic salmon, with such propagation of yellow perch as may be carried on in conjunction with the shad operations. The decline in the catch of shad has limited the bureau's efforts in this field to the

stations at Bryans Point, Md., and Edenton, N. C. An increased number of eggs was obtained by unusual effort at Bryans Point. The take of shad and herring eggs in Albemarle Sound waters was negligible, in spite of a heavy run of fish. The run of shad was preponderantly of male fish, and very few of the females yielded ripe eggs.

There is the ever-increasing possibility of a light run of fish, due to overfishing, pollution, obstructions, etc., and the further chance that no eggs can be secured, even though the fish may be obtainable. The same situation applies in general to the propagation of the river herring. Shad work conducted on the Delaware River in cooperation with the State of New Jersey yielded very few fish, and no eggs were obtained. Previous to the opening of the shad season on the Potomac a large number of yellow perch were hatched at the Bryans Point station. A blizzard in March destroyed the fishermen's nets and seriously curtailed the output of the species in Albermarle Sound. A number of Atlantic-salmon eggs, obtained through exchange from Canada, were hatched and the fry distributed in Maine waters.

COMMERCIAL FISHES OF INTERIOR WATERS

Whitefish, cisco, lake trout, and pike perch, the main species supporting the extensive commercial fisheries of the Great Lakes, are the objects of attention in this field. As the eggs are secured as a by-product of the commercial fisheries, any adverse weather which retards fishing restricts the take of eggs. The various species frequent different localities and have different spawning periods, so that the causes that diminish collections of one species do not affect the others necessarily. There was an increase in the collection of lake trout and cisco eggs as compared with 1926. Whitefish and pike-perch collections declined in comparison with the previous year. Resumption of the practice of penning whitefish at some of the Great Lakes stations has effected a salvage of eggs that would otherwise be lost. A marked increase in the percentage of hatch has followed such practice. Where the eggs are taken by the bureau's experienced employees better quality is assured than when the fishermen themselves take and care for the eggs. The action of the conferences called in Ohio and Michigan urging that the taking of spawn by the fishermen in a proper manner be made a requirement of law should prove beneficial in increasing the output of the stations and in saving the fisheries from further depletion.

Pike-perch operations at Swanton, Vt., were not as satisfactory as heretofore, low water making the penning of adult fish difficult. Work with this species on the Great Lakes was successful, however. Hatching of buffalo fish at Plaquemine, La., was a virtual failure.

SALVAGING FISHES FROM OVERFLOWED REGIONS

Unusually low water during the spawning season, when the fish normally would migrate to the marginal areas and become land-locked, acted as a barrier to such movements. Later in the season, when seining operations have been conducted in other years, high water hindered the rescue work, so that it was difficult to obtain the fish that migrated. As a consequence, the collection of fish from this source was very small and a considerable number of applications for them were left unfilled.

FISHES OF INTERIOR WATERS

Waters well stocked with sport fishes are an important asset to any community, attracting anglers, and thus bringing wealth into the community in many ways. Good trout streams are especially sought after. The bureau finds it necessary to obtain a large percentage of its brook-trout eggs from commercial producers, but most of the rainbow and other trout eggs have been secured from wild fish or from hatchery brood stocks. The bureau's collecting stations for rainbow eggs in the Meadow Creek (Mont.) territory and the Lost Creek and Sage Creek (Wyo.) fields were notably successful, while other smaller projects of a similar nature in the Rocky Mountain territory have been developed. The Meadow Creek field also yielded an increased number of Loch Leven trout eggs during the past year, this immigrant having become more firmly established in the esteem of the angling fraternity. A station for collecting rainbow eggs was established in New Hampshire during the past season under the supervision of the Nashua (N. H.) station. The White Sulphur Springs (W. Va.) station has a fine brood stock of rainbow trout, and the fish have yielded eggs of excellent quality.

Statistics of the collection of black-spotted trout eggs in the Yellowstone National Park cover parts of two fiscal years. The close of the spawning season brought a harvest of eggs surpassing that of the previous year, but not equal to the standard set during the early years of the operations. Glacier Park, as well as the Yellowstone, has received the attention of the bureau.

The operation of the bureau's pond stations, situated chiefly in the Southern States, has resulted in an output surpassing all previous records at several points, particularly at the Cold Spring (Ga.), Tupelo (Miss.), and San Marcos (Tex.) stations. The Louisville (Ky.) station is of especial interest in that it is particularly successful in the production of small-mouthed bass, a species unusually difficult to raise in hatcheries. Some slight damage, not of a serious nature, was suffered at the Mammoth Spring (Ark.) station from spring floods. The superintendent of the Cold Spring (Ga.) station reported considerable success in feeding adult pond fish on shrimp heads, a waste product of a coastal fisheries.

DISTRIBUTION OF FISH

The carrying capacity of the fish-distribution cars has been increased greatly through the introduction of improved equipment, which has made it possible to handle the increased output of the hatcheries. During the fiscal year these cars traveled 63,300 miles, and detached messengers covered 363,565 miles.

The construction of at least one more steel distribution car is absolutely necessary for handling the increased output of fish, as well as for economy and safety in making the distribution. The cars and messengers are now carrying twice as many fish in a single shipment as were carried 10 years ago, so that there is little opportunity for effecting further savings by larger shipments.

COMMERCIAL FISHERIES AND FISHERY INDUSTRIES

REVIEW

According to the most recent statistics available, the fisheries and fishery industries of the United States and Alaska employ about 190,000 persons; their properties are valued at about $210,000,000; the annual sales of fish and fishery products by fishermen are about 3,000,000,000 pounds, for which they receive about $109,000,000; and the output of canned fishery products and by-products is valued at nearly $100,000,000.

With but one important exception, in 1926 the fishery industries may be said to have experienced one of the most successful years. Vessel landings at New England ports were the largest on record; Seattle landings were better than in the previous year; and the fish-canning industry had the most valuable output in recent years.

The exception to the generally successful conditions was the menhaden industry. In recent normal years this industry has an output valued at more than $6,000,000. In 1926 the value was less than $3,500,000, and the resulting condition in this industry is most acute. This is a repetition of what happened in 1924 and is most likely to be repeated frequently as long as no remedial steps are taken. The reduced output was due, of course, to a failure in the supply of menhaden, and the resultant loss was far greater than ordinarily would be expected, as the operating costs are about as high for a $3,500,000 output as for a $6,000,000 output. The reason for the high operating costs in poor years is the failure to foresee such a condition.

It is necessary to keep on full crews at the plants and on the vessels in order to take care of the large catches, which in poor years fail to materialize. This condition might be remedied by investigations of the fluctuations of menhaden, which would permit forecasting the extent of the supply, and technological research to develop more efficient methods in the menhaden plants. These two projects are considered of great importance. Unfortunately, no work on the fluctuations and only a little work on technological processes have been possible with the present personnel and funds.

The bureau's work most directly touching upon the fisheries industries is prosecuted by its division of fishery industries. The operations of this division include the collection, compilaton, and publication of statistics, technological research, and the dissemination of practical information to the industry.

GENERAL STATISTICS

During the past year statistics on the landings of fish at the ports of Boston and Gloucester, Mass., Portland, Me., and Seattle, Wash., were collected and published monthly. Statistics of the cold-storage holdings of fish were collected by the Bureau of Agricultural Economics in the Department of Agriculture and were published monthly by the Bureau of Fisheries as in previous years. Statistics of canned fishery products and by-products for the year 1926 were collected and published early in 1927, and those on the production, holdings, and consumption of animal and vegetable oils in the fishery indus-

tries were collected quarterly and furnished to the Bureau of the Census for publication as in previous years. The annual canvasses of the shad fisheries of the Potomac and Hudson Rivers were made as usual.

The States of Maryland and Virginia were canvassed for general statistics on the personnel, investment, and yield of the fisheries and fishery industries for the year 1925, and, with their publication, statistics of this nature are available on the various geographical sections, as follows: New England States, 1924; New York, New Jersey, Pennsylvania, and Delaware, 1921; Maryland and Virginia, 1925; South Atlantic and Gulf States, 1923; Pacific Coast States, 1922; and the Mississippi River and Great Lakes, 1922.

As the result of State activities, there are available annual statistics on the production of the Pacific Coast States for the years 1922 to 1925, inclusive, and of the Great Lakes for the years 1913 to 1925, inclusive. Statistics on persons, investment, and yield of the fisheries of Connecticut also are available for the years 1924, 1925, and 1926. In these cases original collections were made by the States, and the compilations of the various sections were made by the Bureau of Fisheries. It is to be hoped that more States will undertake work of this nature, for it is on properly collected statistics that we must depend for the facts necessary for the proper conservation of our commercial fisheries. The States, with their direct jurisdiction over the fisheries, are the logical agencies for the collection of such statistics.

MACKEREL STATISTICS

The collection of special statistical data on the mackerel fishery was continued during the past year. A preliminary analysis of these statistical and biological data indicates that the causes of fluctuations in the mackerel fisheries are due primarily to variations in the success of reproduction from year to year. Thus the unusually large runs of mackerel in 1925, 1926, and the early season of 1927 have been due to the unusually large numbers of mackerel spawned and hatched in one year, provisionally determined to be that of 1923. Very few mackerel of other year groups were found in the catch, indicating that the other spawning seasons have been much less successful than that of 1923.

CANNED FISHERY PRODUCTS AND BY-PRODUCTS

The canned fishery products and by-products of the United States and Alaska amounted to $98,326,350 in value in 1926. The output of canned fishery products was valued at $86,193,240, and that of by-products was valued at $12,133,110. The total is the largest in recent years, exceeding 1925 by 3 per cent and 1921 by 79 per cent. The increase is due chiefly to the larger pack of canned salmon in Alaska. Among the canned products, salmon, as usual, was the most important item, contributing 65 per cent of the total value; sardines were next, with 17 per cent; the tuna followed, with 6 per cent; and oysters, shrimp, clams, and miscellaneous products contributed the remaining 12 per cent.

TRADE IN FROZEN FISH

The holdings of frozen fish in 1926 were somewhat less during the first seven months and considerably more during the last five months of the year than in the previous year, varying between 16,154,002 pounds in April to 75,034,255 pounds in November. The average monthly holdings during the year amounted to 45,906,276 pounds, an increase of 4.13 per cent, as compared with the average monthly holding in 1925, and was above the five-year average by 11.71 per cent.

NEW ENGLAND VESSEL FISHERIES

Statistics of the New England vessel fisheries at Boston and Gloucester, Mass., and Portland, Me., collected by the bureau's local agents, have been published monthly. Two annual bulletins were issued—one showing the catch by fishing grounds and the other by months. The total landings by vessels at these ports in 1926 was the largest on record, amounting to 238,426,223 pounds of fish, having a value to the fishermen of $9,068,573. This was an increase over 1925 of 9.94 per cent in the quantity and 11.74 per cent in the value of the products.

The principal species, in the order of their value, were haddock, 94,060,734 pounds, valued at $3,082,924; cod, 78,218,703 pounds, valued at $2,647,479; mackerel, 36,232,655 pounds, valued at $1,406,485; halibut, 3,430,957 pounds, valued at $671,150; swordfish, 2,441,679 pounds, valued at $492,629; and flounders, 6,778,965 pounds, valued at $324,398. Compared with the previous year, there was considerable increase in both the quantity and value of cod and haddock and a large increase in the quantity and value of the catch of mackerel and swordfish.

The total catch of mackerel by the American fishing fleet in 1926 was 304,490 barrels fresh and 5,380 barrels salted, an increase over the previous year of 100,529 barrels fresh and a decrease of 7,062 barrels salted.

FISHERIES AT SEATTLE, WASH.

In 1926 the quantity and value of fishery products landed at Seattle by fishing and collecting vessels was 32,418,430 pounds, valued at $3,598,741.

The catch by fishing vessels, which consisted largely of halibut, amounted to 13,371,610 pounds, valued at $1,896,677. Compared with the previous year, this is an increase of 2.9 per cent in quantity and 19 per cent in value of the products landed. The fish landed by collecting vessels amounted to 19,046,820 pounds, valued at $1,702,064, an increase of 9.5 per cent in quantity and 25 per cent in value.

SHAD AND ALEWIFE FISHERIES OF THE POTOMAC RIVER

In 1926 the shad fishery yielded 336,662 shad that weighed 1,034,206 pounds, valued at $217,461 to the fishermen. This is an increase over 1925 of 65 per cent in number, 48 per cent in weight, and 33 per cent in value. While the catch is not large, compared with many of the

former years for which statistics are available, the fishery has, nevertheless, registered substantial increases since the exceptionally poor year 1924.

The catch of alewives amounted to 13,795,848 fish, weighing 5,518,930 pounds, valued at $55,366 to the fishermen. The catch shows an increase over 1925 of 76 per cent in number, 76 per cent in weight, and 48 per cent in value, and, with the exception of 1924, is the largest catch on record since 1909.

FLORIDA SPONGE FISHING

In 1926 the quantity of sponges sold at the sponge exchange, Tarpon Springs, Fla., was 367,745 pounds, valued at $666,093, of which 235,143 pounds, value dat $592,367, were large wool; 26,073 pounds, valued at $36,502, small wool; 55,205 pounds, valued at $22,682, yellow; 49,233 pounds, valued at $13,441, grass; and 2,091 pounds, valued at $1,101, wire. It is estimated that sponges to the value of $50,000 were sold outside of the exchange at Tarpon Springs. Compared with 1925, there was a decrease in the production of 66,927 pounds, or 15.4 per cent, in quantity, and $49,004, or 6.9 per cent, in value.

FISHERIES OF MARYLAND AND VIRGINIA

Compilation of the statistics of the fisheries of Maryland and Virginia in 1925 was completed during the fiscal year and published in summary form as Statistical Bulletin No. 745. The results show that the fisheries of these States gave employment to 39,091 persons, of whom 25,856 were engaged in fishing operations, 9,671 in the wholesale fish trade, and 3,564 in the canning, salting, smoking, and by-products industries. The investment amounted to $19,322,844, of which $10,635,397 were invested in vessels, boats, fishing apparatus, and shore and accessory property used by the fishermen; $4,259,205 in property and cash capital in the wholesale fishery trade; and $4,428,242 in property and cash capital in the canning, salting, smoking, and by-products industries. The products of the fisheries of these two States amounted to 333,205,769 pounds, valued at $13,948,060. The products of the canning and other fishery industries had a value of $4,936,664.

Oysters, with a production of 60,264,932 pounds, or 8,609,276 bushels, valued at $6,021,606, were the most important fishery product of these States. Other important products were shad, 7,363,856 pounds, valued at $1,636,879; menhaden, 150,492,623 pounds, valued at $1,434,706; crabs, 29,600,605 pounds, valued at $1,249,497; croaker, 25,252,156 pounds, valued at $711,416; squeteagues, 13,924,659 pounds, valued at $668,296; and clams, 1,190,272 pounds, or 148,784 bushels, valued at $468,784.

Compared with 1920, the last available statistical report, there was a decrease of 5 per cent in the number of persons engaged; an increase of 5.7 per cent in the amount of capital invested; and a decrease of 37.2 per cent in the quantity, with an increase of 9.5 per cent in the value of the products landed by the fishermen.

FISHERIES OF THE PACIFIC COAST STATES

During the past year statistics, as collected by the Pacific Coast States, were compiled and supplemented by the bureau's agents. These compilations included 1924 and 1925, and, with the statistics already published, there are available four successive years' data, from 1922 to 1925, inclusive.

On the basis of the most recent year, 1925, the fisheries of the Pacific Coast States employed 16,856 fishermen, 673 vessels of 13,361 tons, and 5,424 motor boats. The total yield amounted to nearly 611,000,000 pounds, valued at nearly $24,600,000. This is the largest yield on record.

The salmon fishery, by far the most important in value, yielded 139,848,020 pounds, valued at $10,149,961. Next in importance was the tuna fishery, which produced 54,776,970 pounds of albacore, tuna, skipjack, and bonito, valued at $4,558,183. Third in importance was the halibut fishery, with 19,256,185 pounds, valued at $2,177,125. The sardine fishery ranked fourth, with 315,294,986 pounds, valued at $2,087,756.

The total yield has increased successively from 405,000,000 pounds in 1923 to 474,000,000 in 1924 and to 611,000,000 in 1925. The value increased from $19,000,000 to $20,000,000 and to $25,000,000 in these same years, respectively. Most of the increased poundage was achieved in the sardine fishery, which almost doubled its yield during the three years. The sudden spurt in value between 1924 and 1925 is due to the unusually large catches of salmon and tuna.

FISHERIES OF THE GREAT LAKES

With the cooperation of the Tariff Commission, statistics of the yield of the Great Lakes fisheries originally collected by the States were compiled for the years 1913 to 1925, inclusive. During this period the United States yield fluctuated between 68,000,000 and 109,000,000 pounds. The average yield during the first half of this period (1913 to 1919) was 94,195,000 pounds per year, while during the last half (1920 to 1925) it was only 78,161,000 pounds. This marked decline has been especially noticeable among some of the most valuable and most sought-for fishes, principally whitefish, herring, chubs, ciscoes, and sturgeon.

TECHNOLOGICAL INVESTIGATIONS

In its technological work the Bureau of Fisheries is endeavoring to improve present practices and to develop new equipment, methods, and products within the fisheries industries and to bring about proper utilization of wastes and by-products. Investigations are made and science applied to the various problems. Results are then made available to the industry, and their application is directed until they become an integral part of the same. The fisheries industries offer a very fruitful field for work of this nature. Rapid progress in industry (and this applies particularly to the fisheries industries) depends largely upon such work, combined with the application of sound business principles.

Work to date has been confined largely to four major lines of research—utilization of by-products, nutritive value of fish and shellfish, preservation of nets, and improvements in merchandising fresh fish.

A method was worked out for decreasing losses of the protein and oil contained in press liquors now discarded in the manufacture of fish meal and oil. The method produces a better oil and should help materially in diminishing pollution from these liquors in our coastal waters. In this connection a careful study of the menhaden industry was made, which revealed that certain steps should be taken to lessen production costs and improve the products, the results of which have been given to the industry.

With the increasing demand for fillets, the quantity of waste that is collecting in certain fish markets has become considerable—sufficient to enable profitable by-products industries to be prosecuted with the development of suitable methods for handling the gluey waste from such fishes as cod and haddock. Such a method has been worked out, and the results of this work are being made available to those in the industry unable to overcome the present difficulty.

The bureau has issued a document on the nutritive value of fish and shellfish, with chapters by experts on the chemical composition, mineral constituents, vitamins, oils, and fats, and protein value of aquatic foods. This has been very helpful in creating a better realization of the place of fish and shellfish in the diet. To add to our knowledge of the value of the proteins in fish, the bureau is conducting an investigation at Johns Hopkins University under the direction of Dr. E. V. McCollum, which indicates that the proteins in herring and haddock have high nutritive value, comparable with meat. Extensive tests are now in progress regarding the nutritive and corrective values of selected grades of fish meals, as demonstrated by rat-feeding experiments.

Large-scale practical tests with copper oleate and copper paint mixture net preservatives have been conducted at points on the coast of North Carolina, Virginia, and New Jersey, in which trap nets and purse seines were used. In addition, experiments with a large number of new preservatives are in progress at the Beaufort (N. C.) station.

Perhaps the most fertile field for experimentation lies in improvements in the methods of handling fresh fish from the place of capture until the product reaches the consumer. Holding or ripening meat improves its quality; the opposite is true of fish. The bureau has made a most important contribution to this branch of industry through the issuance of a handbook on the refrigeration of fish. This includes a history of the industry and important scientific principles involved; changes that take place in the fish in the fresh state and during freezing and holding; design, construction, and equipment of fish freezers; practical freezing methods; methods of brine freezing; transportation of frozen fish; and many other points essential to the proper understanding of the industry, its problems, and the product as a food.

Experiments are now in progress to improve the quality of fish as landed by the fishing vessels and to reduce overhead expense through the adoption of labor-saving devices.

The bureau also is arranging to provide research associate facilities, whereby firms or groups having special technological problems

to solve will furnish the investigator and pay his salary and incidental expenses, the investigation to be carried on under the direction of the bureau's experts and the bureau's equipment to be used so far as available. The bureau reserves the right to make public the results of all such cooperative investigations.

Because of the extreme difficulties confronting the menhaden industry, particular attention is being given to the problems of that industry, especially to the possibilities of developing improved methods of manufacture that will cut down the extremely heavy labor cost of present practices, yield high-grade oil and meal, and obviate losses in the process of manufacture.

Epoch-making progress characterized developments in the fishery industries. Machine processes are being developed; cleaning and cutting machinery, mechanical conveyers, and packing machines are replacing hand labor. The packing of fresh fish in cartons and packages permits of its wider distribution by retail grocery stores and is tending to distribute sales more evenly throughout the week. The value of carbon dioxide ice for icing refrigerator cars, as well as for preserving smaller shipments, is being demonstrated; and the development of means of freezing fish rapidly with brines indicates that such methods are rapidly approaching a state of perfection that will permit of their use in the large-scale production of frozen fish required by this important branch of fresh-fish preservation and distribution.

BIOLOGICAL INVESTIGATIONS

FISHERY RESEARCH

A brief survey of the year's work shows gratifying progress in many fields. The culmination of many years of salmon investigation in the formulation of a successful plan of protection of the salmon fisheries of Alaska and the promise of reliable forecasting of future years' runs is one of the most satisfying results of the efforts of the fisheries investigators. Oyster investigations have been expanded and are yielding fruits of inestimable value to a great industry reaching from Cape Cod to Texas. Not only have immediately applicable recommendations with regard to oyster culture been offered to the several States, but fundamental investigations on the biology of the oyster itself have been conducted, which will make possible a greater production of this valuable mollusk.

Notable progress also has been made in the conquest of fish diseases which have seriously curtailed the output of the many fish hatcheries scattered throughout the country. These investigations in the pathology of fish and experimental fish culture have gone far to increase the effectiveness of hatcheries and eventually may place the farming of fish in ponds upon a successful and lucrative basis.

The enthusiasm and energy of the investigators have been stimulated materially by a conference of the entire staff of the division of scientific inquiry held in Washington, D. C., in January.

As in previous years, many States have cooperated with the bureau's investigators, thus making possible a more effective and more extensive investigation than would otherwise be possible. Joint investigations by the bureau and the State governments include work

on the oysters in Georgia, North Carolina, South Carolina, Mississippi, and Texas; salmon investigations in California, Oregon, and Washington; a study of food supply in lake waters in Michigan and Wisconsin; and mussel investigations in Arkansas.

Following is a brief résumé of the results of the more important activities of the division:

INVESTIGATIONS OF THE FISHERIES OF THE NORTH ATLANTIC

Tagging operations in the summer of 1926 were continued from August to October, the total number of cod, haddock, and pollock tagged amounting to 4,235. The work was carried on from the fisheries steamer *Albatross II*, chiefly in the waters south of Cape Cod, on Georges Bank, and off Mount Desert, Me. The tagging work was resumed in April, 1927, the program including further tagging on Georges, Browns, and Fippenies Banks as well as on the inshore grounds in Massachusetts Bay and along the coast of Maine. Three cruises were made before the close of the fiscal year, during which 3,602 cod, pollock, and haddock were tagged, bringing the total of the fiscal year 1927 up to 7,847, and for the entire experiment since 1923 to 43,699. The recapture of tagged fish during the present season has been satisfactory, but a greater proportion is expected during the autumn and winter.

During the spring operations an otter trawl was used with considerable success, even on rocky grounds, for taking the smaller cod and securing a better representation of the immature members of the population. An extensive collection of scales has been taken; many of them have been studied, and the intensity of fishing and the size and age composition of the stock on the grounds has been determined.

In order to determine further the interdependence of the various fishing banks, studies of the abundance and distribution of cod eggs in Massachusetts Bay have been continued, and a report covering the observations made during 1924 and 1925 from the *Fish Hawk* has been completed.

Through extensive observations of the commercial run of mackerel at several of the major ports, an understanding of the composition of the mackerel stock entering the commercial fishery has been gained.

The studies of the spawning areas also have been continued. Observations on the southern fishing grounds, from Long Island to Delaware, were made during the spring of 1927, and through systematic tow-net collections of eggs and larvæ an attempt is being made to discover the relative success of spawning each year. At the same time the tagging experiments to trace the migrations of the fish have been continued, and it is confidently expected that through the early detection of successful spawning years, and from knowledge of the biology of the fish and its habits, the extent of future runs may be predicted.

Both fresh and salt water smelts are being studied. The salt-water smelts are suffering rapid extermination, and these studies of life history and habits, as interpreted by modern methods of fishery research, will provide the basis for definite recommendations for regulation of the fishery. In addition, extensive collections of trouts and chars, made in many localities through North America, are re-

ceiving attention with a view to distinguishing the many races and specifically determining which are most satisfactory for continued artificial propagation.

INVESTIGATIONS OF FISHERIES OF THE SOUTH ATLANTIC AND GULF COASTS

Fisheries investigations in the South Atlantic region are being centered at the Beaufort (N. C.) biological station. The fisheries receiving particular attention at present are those for mullet, other shore fisheries, the scallop, oyster, and terrapin. Tagging mullet to determine the limits of its migration was extended somewhat, about 1,000 fish being tagged and liberated in the vicinity of Beaufort, with results that corroborated last year's findings. Studies on the cape mullet to determine their origin and importance in maintaining the stock of local fish are also receiving attention.

During the past year systematic tow-net collections were made, both inside the sound, in the vicinity of Beaufort, and offshore toward the Gulf Stream, to aid in studying the spawning periods and localities and the early development of the more important commercial fishes of that region. Previously unknown larvæ of the spot, croaker, gray trout or squeteague, menhaden, pigfish, and many other species were taken.

The scallop investigations begun in 1925 were continued. The scallop fishery is of considerable importance, the only producing grounds in the South being in the vicinity of Beaufort, N. C. The yield is subject to considerable fluctuation, however, and the investigations aim to determine the intensity of fishing that can be practiced without completely depleting the beds. The rate of growth and the abundance of the new generations and the mortality of the adults have been determined accurately, and a basis for regulation has been established. New beds were discovered recently, and conditions favoring growth in other localities have been examined.

Experiments in terrapin culture at Beaufort, initiated more than 25 years ago, have resulted in developing a practical method of cultivation, which now is followed extensively. The State of North Carolina is cooperating with the bureau by furnishing breeding adult terrapin and by hatching thousands of young terrapin for distribution in the marshes. A closed season of five years was established in 1925 for the protection of the terrapin, and it is believed that the extended program of restocking waters will restore the North Carolina terrapin fishery to a productive condition within a few years. Many of the adult terrapin provided by the State in 1925 to form the brood stock of the station began laying in the summer of 1927.

Investigation of the shore fisheries of Texas has been continued vigorously in both field and laboratory. Fisheries on the coast of Texas are in a very backward state, due, according to different views, to depletion or to lack of development. State authorities have attempted to protect the fish on the spawning grounds. During the past year investigations have been designed to discover the exact spawning areas and also the outstanding facts of the life history of the important commercial sea fish—spotted trout, drum, and redfish—and a report on the subject is being prepared. In addition, a study of the fish fauna of the entire Texas coast is being made.

OYSTER INVESTIGATIONS

The oyster investigations were extended considerably during the last fiscal year and were as follows: (1) Experiments for increasing the collection of spat; (2) study of the factors controlling setting; (3) study of the spawning of the oyster; (4) surveys of natural oyster beds and reefs; and (5) study of the drill, chief enemy of the oyster.

Inasmuch as the principal cause of the decline of the oyster industry in northern waters has been the inability to obtain a yearly crop of seed oysters, the purpose of experiments carried on at Milford Harbor, Conn., and Wareham River and Wellfleet, Mass., has been to discover a practical method of producing this annual supply. A new method for the control and production of seed oysters has been developed, which consists essentially in the establishment of spawning beds in bays, harbors, and river mouths, and the planting of crates filled with shells in the vicinity of oyster beds for the collection of set.

The crates were triangular in shape, of spruce lath, having a capacity of 2 bushels, and each covering an area of 2 square feet. They were planted in various formations on the tidal flats, so as to determine their efficacy as seed collectors and the effect of their position and arrangement on the uniformity or intensity of the set. In Milford Harbor 300 crates collected an average of 2,000 spat per bushel of oyster shells. Fifty crates were set in Wareham River, Mass., and yielded from 1,900 to 45,000 spat per bushel. Setting occurs here between tide marks and was found to be heaviest about 1½ feet above the bar on which shells are planted by the local oyster men. In Wellfleet 97 crates were planted, and, though no set of commercial importance occurred, the crates in Herring River collected a fairly good set, ranging from 1,200 to 2,800 per bushel.

Additional experiments and observations on the factors controlling setting have been undertaken in Long Island Sound by means of drift bottles, tide gauge, current meter, and spat collectors.

The following practical applications of the experiments can be made: (1) In certain localities the oysters can be induced to spawn by adding sperm to the water, and (2) for successful spawning the oysters should be planted on the spawning grounds as densely as possible.

At the request of the States, surveys of the oyster grounds were made in Massachusetts, North Carolina, South Carolina, Alabama, Mississippi, and Texas, to ascertain the practical measures suitable for each region that should be adopted in order to prevent further depletion of the natural reefs and to maintain or, if possible, to increase the production of oysters.

It has been found that in certain regions in Massachusetts, as, for example, Wareham River, Onset Harbor, and Centerville River, the production of seed oysters can be increased considerably by adoption of a new method of spat collection and by restocking the depleted oyster beds (Centerville River). The other localities (Waquoit, Cotuit, and Chatham) are suitable as oyster-growing grounds only.

In South Carolina oyster production can be increased by transplanting seed oysters from the tidal flats to the bottoms below low-water mark, where setting does not occur. It has been recommended

to return a greater quantity of shells to the natural beds, to extend the beds by planting shells on adjacent firm bottoms, to restore the depleted oyster beds by planting seed and adult oysters, to collect the set on brush and shells planted on tidal flats, and to transplant it on suitable bottoms below low-water mark.

The survey of Texas waters covered the region from Corpus Christi to Galveston and has shown that oyster reefs in these coastal waters produce enormous quantities of oysters, some of which have little market value. It was recommended that the overcrowded reefs be used as the source of an almost unlimited supply of seed oysters, and to plant them on the bottoms of the following bays: Aransas, Mesquite, Lavaca, north of Sandy Point, Kellers, Karankawa Reef, Trespalacios, and Matagorda between Portsmouth and Pallacios Points.

The work in North Carolina consists chiefly in a hydrographic study of Pamlico Sound with reference to oyster culture. The temperatures, salinities of the water, sedimentation and shifting of the bottom, and the distribution of the oyster set have received particular attention throughout the entire year. One of the most serious problems in planting oyster shells is the danger of the set being smothered with sand or silt by shifting currents. Studies on sedimentation and currents, therefore, are designed to discover the areas where cultch can be planted safely and where producing beds can be extended by artificial means. The State of North Carolina has cooperated actively by furnishing a vessel for this research work. Some of the studies were conducted at the Beaufort biological laboratory and some in the soils laboratory of the University of North Carolina.

In Mississippi Sound and in Mobile Bay observations on the hydrographic conditions that affect oyster culture in that region have been under way throughout the year. Experiments on the use of brush as spat collectors have been undertaken on a large scale, and favorable results through the coming growing season are anticipated. Present observations in Mississippi Sound tend to show that the productiveness of oyster beds can be increased by the planting of shells and brush in order to utilize the abundant natural set.

Because of the extensive depredations of the drill in the oyster beds of Chesapeake Bay, a study is being carried on at Norfolk, Va. (where a temporary laboratory has been established), with a view to finding an efficient method for combatting this pest. A thorough study of the life history of the drill is under way, including field and laboratory observations on the spawning habits, feeding habits, migrations, and distribution of the animals. If the abundance of the oyster drill in Chesapeake Bay can be reduced, a saving of thousands of dollars to the oyster industry will be effected.

A number of minor surveys and inspections of oyster grounds have been made. At the request of the National Research Council, observations were made in the vicinity of Tampa and Key Largo, Fla., for the purpose of determining whether conditions there were suited to the cultivation of the Japanese pearl oyster. Black Water Sound, Palmasola Bay, and Largo Sound were found to be suitable for experiments in artificial pearl culture.

At the request of the Alabama Fish and Game Commission, a brief survey of the oyster bottoms in Mobile Bay was made during April, 1927, to determine the abundance and character of oyster growth on

the natural reefs, and particularly as to whether or not dredging oysters on certain reefs would be harmful. Observations indicated that dredging north of the line extending from Alabamaport to Fish River not only would do no harm but would improve the condition of the reefs and increase their productiveness, provided the culling laws were observed.

FISHERIES OF THE PACIFIC COAST AND ALASKA

Besides successfully discharging the duties of protecting and administering the salmon fisheries of Alaska, based on present knowledge of the life histories and biology of the various species, the bureau is making rapid progress toward a more complete understanding of the factors that regulate the abundance of salmon from year to year and in checking the depletion. The salmon fisheries of Alaska depend upon five distinct species of wide distribution, each of which is represented by an independent, self-perpetuating colony in every stream that affords suitable conditions for its existence. Each colony is independent of all others, and, inasmuch as it secures no recruits from adjacent streams, its maintenance depends on an adequate spawning reserve to produce the eggs for succeeding generations. The regulatory function of the Bureau of Fisheries, therefore, consists in adopting and enforcing regulations of the fisheries that will permit a sufficient number of adults to reach the spawning grounds of each salmon stream throughout the region.

A program of investigation was adopted in 1921 with the purpose of discovering how large a spawning reserve is necessary, and this program has been followed assiduously and has been extended under the auspices of the Pacific Salmon Investigation Federation to include the entire salmon fisheries on the Pacific coast. The essential part of the problem is to ascertain the complete returns from spawning colonies of known size. The Karluk and Chignik Rivers have been selected because of favorable natural conditions in which to conduct the studies. Weirs have been constructed, and investigators have been stationed at them to make necessary observations, and it is confidently expected that a reliable basis for the prediction of the magnitude of future runs of salmon will be developed. A report on this subject has been prepared.

In order to determine the migration routes of fish, extensive tagging experiments have been continued for several years. A report covering these operations in Alaska in 1926 adds much to our knowledge of the routes of travel of the salmon from the sea to their spawning grounds and indicates the source of supply. Plans have been made for the spring and summer of 1927 to extend the tagging of salmon caught by trolling in the ocean. The work will be conducted by representatives of the bureau in Alaska and various State authorities along the coasts of Washington, Oregon, and California. Specific studies on Karluk Lake have been instituted to determine the reason for the unusually rich production of salmon in the Karluk River system.

During the past 10 years the Bureau of Fisheries, in cooperation with the Oregon Fish Commission, has conducted marking experiments as a means of studying the life history of the salmon in the

Columbia River. Fingerlings have been marked by removing various fins and have been liberated under varying conditions in the river.

The herring fishery of Alaska has been receiving greater attention recently. The growing use of herring for food and manufacture into oil and meal has aroused considerable anxiety concerning the danger of depletion. Biological investigations of the herring begun in the spring of 1925 have been continued, and extensive studies of the segregation of the various races have been made. In addition to the studies of the physical proportions of the fish as a means of distinguishing the racial units of the fish population, which were made last year, a tagging program has been undertaken. During the spring of 1927, 3,000 herring were tagged, and studies of the early development were begun by making tow-net collections of larval herring.

The only other subject of detailed study by the bureau was the razor clam. Studies have been conducted on representative beds throughout the Pacific coast, and several reports already have been published outlining the general features of the life history of this clam. During 1926 and 1927 a comprehensive study on rates of growth, according to latitude, on the Pacific coast has been in progress, and data of direct use in regulating the fishery in Alaska have been collected. Thorough annual observations of the more important beds are made and the trend and abundance of the resource accurately determined, and regulations governing the fishery in Alaska for the following year are drawn up in accordance with actual needs.

FISHERIES OF THE INTERIOR

The investigations of the inland fisheries are centered at the fisheries biological laboratory at Fairport, Iowa, for the Mississippi River district, and at the University of Michigan, Ann Arbor, Mich., for the Great Lakes. Investigations at Fairport are concerned chiefly with the artificial propagation of fresh-water mussels, which provide the raw material for the manufacture of pearl buttons and novelties, and with studies on the pond culture of fresh-water food fishes.

The most important work along this line conducted at the Fairport laboratory in recent years consists in developing a nutrient solution that serves as a medium for the growth of larval mussels without passing a period of parasitic life on the gills of various fishes. In addition to the trough-cultural methods devised as a result of earlier studies, great numbers of fish rescued from overflowed lands in the Mississippi Basin are infected with the glochidia of mussels before they are returned to the river. This work of the bureau has received enthusiastic support from the button industry, as the increasing cost of labor and the scarcity of raw materials are proving a serious handicap to the industry.

The process of rearing larval mussels in a nutrient solution, evolved by Dr. Max M. Ellis, of the University of Missouri, promises greatly to simplify the propagation work of the bureau and tremendously increase the output of juvenile mussels at an age and stage of development that virtually insure survival. Moreover, it will permit their being planted in areas suited to their rapid development, and which can be controlled, thus making mussel farming on an extensive scale

possible. Plans are being made for adapting the laboratory process to large-scale operations.

At the request and with the cooperation of the Arkansas Game and Fish Commission, a brief survey was made of the more important rivers in Arkansas for the purpose of devising a more satisfactory code of fishery regulation to prevent overfishing and permit full utilization of productive mussel beds. A plan of alternately opening and closing certain sections was devised to afford maximum protection with minimum loss or inconvenience to the industry. Surveys of portions of the upper Mississippi River and certain rivers in Virginia also were made during the year to determine the state of the resource, so that recommendations for regulations could be made.

The need has been felt for more complete knowledge of the growth of commercially valuable mussel shells in order that localities where growth is rapid might be stocked heavily with the more valuable or more rapidly growing species. Satisfactory methods for determining age were worked out, and studies of the rates of growth of several important species were completed. A report on this work has been submitted.

An investigation begun by Dr. R. E. Coker in 1914 was taken up again by him and completed. This was a study of the effects of the dam at Keokuk, Iowa, on the fish population above and below the dam. A report that contributes much to our knowledge of the fish of this region has been completed.

A brief investigation of the pollution of the upper Mississippi River was conducted during the fall of 1926 at the request of the Joint Interim Committee of the States of Wisconsin and Minnesota. Plans were made for a joint sanitary and biological survey of the upper Mississippi River by the Public Health Service and the health departments of the States and the Twin Cities, and the bureau was requested to conduct the biological survey. Due to lack of funds and the short time available for completion of the report, only a limited program was undertaken. The abundance and character of the bottom life and of the plankton of the river were determined at various stations over a distance of about 200 miles, and observations on the fish life were made at the same time. A report of the findings showed that during the summer and fall the effects of pollution from the Twin Cities extends down the river for about 85 miles. Throughout this distance fish life suffered greatly and in areas of extreme pollution was entirely absent.

Plans for extending the investigations of the commercial fisheries in the Great Lakes, made possible through additional appropriations by the last Congress, have been made. In 1927 and 1928 the work will be confined to studies of conditions on Lake Erie to ascertain, if possible, the factors involved in the presumed depletion of certain species; to obtain an understanding of the nature of all biological and economic problems that affect the commercial fishing industry of the Lakes; to study the biology of the more important commercial and game fishes; and to acquire reliable data essential to drafting rational and uniform regulations for the fisheries of Lake Erie and, so far as may be applicable, of the other Great Lakes.

An agreement providing for extensive cooperation between investigators of the bureau and of the State of Ohio has been made for the conduct of experimental fishing, the study of the commercial catch,

and studies on the environment of the fishes in Lake Erie. The State of Ohio will provide investigators to carry on a series of biological studies on the conditions of fish life in the lake. The bureau's staff, working in cooperation, will study the biological aspects of commercial fishing. In addition to these studies, the economic aspects of the regulation of fishing gear and the type of legislation required to restrict abuses in the fishery will be considered. The State department of agriculture, division of fish and game, will furnish and operate a vessel for the conduct of this work.

PATHOLOGY AND EXPERIMENTAL FISH CULTURE

Three important lines of investigation are being followed in the field of aquiculture—(1) pond culture of warm-water fishes, (2) experimental trout culture, and (3) pathology of fishes. Experiments in the production of basses and other food fishes of the Mississippi River region have been carried out in the ponds at the Fairport biological station in an attempt to increase the food supply through fertilization of the waters and to increase the production of fish through proper handling of the fish themselves. Detailed chemical and biological examinations of the ponds are carried on throughout the growing season to determine the conditions most favorable to fish growth; and an attempt is being made to develop a measure of productiveness by which natural pond and swamp areas throughout the country may be determined, so that those suited for the production of fish may be stocked and conditions in others improved. Experiments in producing forage fish, such as the black-head minnow, have been markedly successful, and the advisability of using forage fish as food for bass was clearly evidenced by a considerably increased yield of healthy fish. Through cooperation by the division of fish culture, arrangements were made to begin the pond-cultural experiments on a larger scale at the Neosho (Mo.) fish-cultural station; and in addition to cultivating largemouth bass, experiments in the rearing of smallmouth bass and trout were undertaken here in the spring of 1927.

The work at the Holden (Vt.) experimental fish hatchery has been devoted to the solution of problems arising in the culture of several species of trout. Feeding experiments have been conducted for several years, in which the value of various diets for trout fry has been determined. In an attempt to develop a superior brood stock, selective breeding experiments have been undertaken. A stock of select brood trout has been secured from various places and tagged for future identification. The eggs from the various types of fish were segregated and the young reared in separate pools. It is believed that such qualities as rapidity of growth, strength and vitality of young, resistance to disease, and fecundity can be improved materially in hatchery-reared trout. The capacity of the experimental hatchery at Holden has been increased by additional ponds and raceways, and the whole station has been brought up to a high level of efficiency.

Closely related to the work on pond culture and experimental trout culture is the study of fish diseases. Heavy annual mortality at the Holden station has been overcome through treatment of diseases and parasites, and a study of the cestodarian parasites of bass has been undertaken at the Fairport station and at the Neosho (Mo.) hatchery.

The isolation of several microorganisms that cause diseases in fish and the devising of methods of control were accomplished during the past year, and reports on this work are almost completed. Through the conquest of disease, it is anticipated that a marked increase in the output of the many State, Federal, and private hatcheries throughout the country will result, for fish culturists generally are recognizing the fact that fingerlings held in hatcheries for a long time have a greater chance of survival after planting than those planted in the fry stage. To avoid heavy losses in many hatcheries, the fish are planted in early stages of development and thus fall prey to many enemies when least able to care for themselves. Reducing hatchery diseases, therefore, will increase the output of fingerling fish, and hence the effectiveness of fish-cultural stations.

ALASKA FISHERIES SERVICE

ADMINISTRATION OF FISHERY LAWS AND REGULATIONS

In administering the fisheries of Alaska in 1926 there was no marked departure from the general conservation policy adopted upon passage of the act of June 6, 1924, which expanded the authority of the Secretary of Commerce to denote the time, place, and manner of commercial fishing operations. During the progress of the season's operations some extensions of the regulations were necessary to prevent overfishing in certain places and to meet unusual conditions that arose. The Commissioner of Fisheries was in Alaska during much of the active salmon-fishing season to give immediate attention to necessary changes in the regulations.

The act of June 18, 1926, reenacting and expanding section 1 of the act of June 6, 1924, further broadened control over the fisheries of Alaska by giving the Secretary of Commerce authority to permit the taking of fish or shellfish, for bait purposes only, at any or all seasons in any or all Alaskan Territorial waters. This made possible more satisfactory regulatory measures for the taking of herring for bait purposes in the halibut fishery.

Under date of December 22, 1926, there was a general revision of the fisheries regulations to be effective in 1927. The chief change was the closing to commercial fishing for salmon of 14 localities, in addition to the 99 previously closed. Three of the latter were opened part of the season, and in two others fishing with limited gear was permitted in specified periods.

With few exceptions, the 1,200 or more streams ascended by salmon had good escapements to the spawning grounds. The constant aim and purpose is to secure full compliance with that part of the act of June 6, 1924, which declares it to be the policy of Congress that there shall be an escapement to the spawning grounds of at least 50 per cent of the runs of salmon. The effect of the existing regulations upon the escapement can be gauged satisfactorily by maintaining weirs, through which salmon can be counted, and then checking the results with the commercial take of salmon in the vicinity. In 1926 such weirs were maintained in eight streams in Alaska. Additional weirs will be constructed from time to time as funds and facilities permit.

There was a further expansion in 1926 of the patrol for the protection of the fisheries of Alaska and the enforcement of the laws and regulations. Identified with this work were 13 regular and 145 temporary employees, exclusive of those on the bureau's 11 vessels and the 12 chartered boats, or an increase of 13 persons and 2 vessels over the previous season. In addition, a number of small launches were used for varying periods. This expanded patrol was of particular value as a deterrent to violations, for with few exceptions there was satisfactory observance of the fishery laws and regulations. Before another season the bureau will have added two new patrol vessels to its Alaskan fleet, both of which will be capable of offshore duty when necessary.

SALMON HATCHERIES

The Federal Government operated fish hatcheries at Afognak and on McDonald Lake, at which 52,010,000 red-salmon eggs were collected in 1926. In addition, several million steelhead-trout and humpback-salmon eggs were secured. Two privately owned hatcheries took 41,420,000 red-salmon eggs, and in addition one of them obtained 6,640,000 humpback-salmon eggs.

The Alaska Territorial Fish Commission maintained hatcheries at Ketchikan, Cordova, and Seward. At the Ketchikan hatchery 3,337,760 red-salmon eggs, 1,660,000 humpback-salmon eggs, and 2,000,000 king-salmon eggs were collected and received. At the Seward hatchery 3,164,000 red-salmon eggs were collected. No eggs were taken at the Cordova station in 1926.

SPECIAL STUDIES AND INVESTIGATIONS

During the season of 1926, 13,530 salmon were tagged and released for the purpose of securing further information in regard to migration routes. Scientific investigations of the life history of the salmons were conducted in various parts of Alaska, chiefly in the Karluk River region. Extensive observations were made on various salmon-spawning grounds to determine the adequacy of the salmon escapement and to supplement the information obtained at the counting weirs. Conditions were generally satisfactory, but in some instances the number of spawning salmon appeared to be insufficient.

Additional scientific studies were made in regard to the herring and clam fisheries.

PRODUCTS OF THE FISHERIES

The pack of canned salmon in Alaska was the largest in the history of the Territory, amounting to 6,652,882 cases. Compared with the preceding year, the pack of red salmon increased more than 100 per cent, humpbacks about 58 per cent, cohos over 25 per cent, and kings about 5 per cent. The pack of chums decreased about 16 per cent. The increase in the pack was due largely to a greater take of red salmon in western Alaska and of humpbacks in central Alaska.

The total value of the manufactured fishery products of Alaska in 1926 was $54,669,882. The value of the catch to the fishermen was approximately $14,500,000.

The entire Alaska fishery industry gave employment to 28,052 persons, as compared with 27,685 persons in 1925, and represented an investment of $74,557,522.

The extent and condition of the Alaska fisheries in 1926 and of the activities of the bureau under the laws and regulations for the protection of the fisheries are covered in detail in the annual report of the Alaska service for that year.[2]

ALASKA FUR-SEAL SERVICE

GENERAL ACTIVITIES

Activities at the Pribilof Islands during the year continued in general along the lines heretofore followed. The take of sealskins was satisfactory, exceeding somewhat that of the previous year, and the usual annual computation showed a substantial increase in the size of the herd. A sufficient number of 3-year-old males was marked and reserved for future breeding requirements. Foxing operations progressed satisfactorily.

Good progress was made in the construction of new buildings and in other improvements, including roads. The new buildings are largely to replace former structures, which through age have deteriorated so that they can no longer be kept in repair. The desirability of shortening seal drives and the advantages to be derived from the use of motor-driven vehicles make suitable roads a matter of much importance.

Food, fuel, clothing, shelter, and medical and educational facilities were provided 344 native inhabitants of the islands. The issues of food and other necessaries of life were supplemented by cash payments on the basis of 75 cents for each sealskin and $5 for each fox skin taken, in return for which the natives perform the general work at the islands. Additional small payments were made for certain special services. A staff of white employees supervises all work at the Pribilof Islands.

Through the courtesy of the Navy Department, the general supplies for the fiscal year 1927 were transported from Seattle to the Pribilof Islands by the United States steamer *Vega*, and the sealskins were shipped from the islands on that vessel. The bureau is also indebted to the United States Coast Guard for many services rendered by vessels on the fur-seal patrol.

SEAL HERD

On August 10, 1926, the Pribilof Islands fur-seal herd was computed to contain 761,281 animals. This was an increase of 38,231, or 5.29 per cent over the corresponding figure for 1925.

TAKE OF SEALSKINS

In the calendar year 1926 there were taken on the Pribilof Islands 22,131 fur-seal skins, of which 16,231 were from St. Paul Island and 5,900 from St. George Island. This was an increase of 2,271 over the number taken in 1925.

---

[2] Alaska Fishery and Fur-Seal Industries in 1926. By Ward T. Bower. Appendix IV, Report United States Commissioner of Fisheries for 1927, pp. 225–336, 15 figs. Bureau of Fisheries Document No. 1023. Washington.

MARKING OF RESERVED SEALS

In 1926 the bureau marked 9,565 3-year-old male seals to be reserved for a future breeding stock, of which 7,558 were on St. Paul Island and 2,007 on St. George Island. In addition to the seals marked, there were remaining at the end of the year the 3-year-old males that never were taken up in driving operations. The method of marking was to clip a patch of fur from the upper part of each animal so that it might readily be distinguished thereafter.

SALE OF SEALSKINS

In the fiscal year 1927 two public-auction sales of fur-seal skins taken on the Pribilof Islands were held at St. Louis, Mo. The first sale was held on October 11, 1926, when 6,767 black dyed, 1,250 logwood-brown dyed, 54 golden-chestnut dyed, and 3 dressed skins, a total of 8,074, were sold at a gross price of $308,844. At the same time 181 Japanese fur-seal skins were sold for $4,402, of which 151 were dyed black and 30 were raw salted. These 181 skins were the United States Government's share of sealskins taken by the Japanese Government in 1924 and 1925. In 1926 the Government received 132 skins as its share of Japanese sealskins. There were also sold one confiscated sealskin (black dyed) and four pieces of confiscated dressed and dyed sealskin for $42.

At the second sale, held on May 23, 1927, 11,611 black dyed, 1,526 logwood-brown dyed, and 91 faulty skins, a total of 13,228, were sold at a gross price of $436,566.20.

Special sales of sealskins in the fiscal year 1927 consisted of 68 raw salted, 50 black dyed, and 7 logwood-brown dyed skins at a gross price of $4,324.04. All were taken at the Pribilof Islands.

FOXES

Fox feeding was continued on both St. Paul and St. George Islands in the winter of 1926–27. Specially prepared food was used, and in addition preserved seal meat was fed on St. George Island.

There were sold at public auction on October 11, 1926, at St. Louis, Mo., 465 blue-fox skins taken at the Pribilof Islands. The gross price realized was $24,740. Three hundred and forty of these skins were taken in the season of 1924–25, and 125 in the season of 1925–26. There were also sold at the same sale, for $1.50, three skins taken from foxes that died in course of shipment from the Pribilofs.

In the season of 1926–27, 118 blue and 27 white skins were taken on St. Paul Island and 610 blue and 3 white skins on St. George Island, a total of 758 skins. During the season of 1926–27, 125 males and 108 females were marked and released for breeding purposes on St. Paul Island and 205 males and 202 females on St. George Island. The stock actually reserved for breeding was larger, because a considerable number of animals are never caught at all. In order to improve the herds on each island, 10 pairs of foxes from St. Paul were released on St. George Island, and a similar transfer was made from St. George Island to St. Paul Island.

FUR-SEAL SKINS TAKEN BY NATIVES

By the provisions of the North Pacific Sealing Convention of July 7, 1911, natives of the Pacific coast may, under certain restricted conditions, take fur seals at sea. Before sealskins secured under these conditions can enter into commerce, they must be authenticated as having been taken lawfully. One thousand and seventy-five sealskins taken in the sealing season of 1926 have been authenticated by the Government, 40 of which were taken in the offshore waters of southeast Alaska and 1,035 from waters off the coast of Washington. Through the courtesy of the Interior Department, the latter skins were authenticated by the superintendent of the Neah Bay Indian Agency.

FUR-SEAL PATROL

An adequate patrol of the waters frequented by the Pribilof Islands fur-seal herd was maintained by vessels of the United States Coast Guard, supplemented in southeast Alaska by one of the bureau's fishery patrol vessels.

PROTECTION OF SEA OTTERS, WALRUSES, AND SEA LIONS

The protection of sea otters, walruses, and sea lions was along the usual lines. The killing of sea otters is prohibited at all times, both in Territorial and extraterritorial waters. The extreme scarcity of this valuable and formerly numerous animal will necessitate years of thorough protection to enable its reestablishment in even limited numbers as compared with its abundance of former times. The present regulations prohibit the killing of walruses and sea lions in Alaskan waters until April 30, 1928, except for purposes of securing food or clothing; and in the case of sea lions, except as may be necessary for the protection of property or while such animals are actually engaged in the devastation of runs of salmon.

VESSEL NOTES

The investigation of the fisheries of the Gulf of Maine, in which the *Halcyon* has been employed, was undertaken this year by the *Albatross II*, the former vessel having been laid up. The reconditioning of the latter steamer was sufficiently advanced to permit of her going to sea early in August, and the investigation was carried on as continuously as available funds would allow. The steamer cruised 4,291 miles and made 69 oceanographic stations, and 7,785 fish were caught, tagged, and liberated. Some faults have developed in the ventilating system, but these will be corrected during the coming year.

The *Gannet* and the *Halcyon* were not operated, but the other two steamers and motor vessels carried on the usual fish-cultural and biological work on the Atlantic coast and interior waters.

In the fiscal year 1927, 11 vessels of the Alaska service cruised more than 67,000 nautical miles. Of these, the *Brant* made over 17,000 miles and the *Eider* about 11,000 miles.

In addition to general patrol work in the waters of southeastern and central Alaska, the *Brant* was detailed during part of the winter to certain duties off the coast of California. This vessel, which is 100 feet in length and equipped with a 225-horsepower Diesel engine, was built in 1926 and has proved a highly satisfactory addition to the fleet.

The *Eider* continued as local tender for the Pribilof Islands, with base at Unalaska, and rendered some service in connection with salmon-fishery conservation.

In southeastern Alaska the *Widgeon*, *Murre*, and *Auklet* were engaged on fishery protective work. The *Kittiwake* was similarly employed in the Cook Inlet region, the *Blue Wing* in the Kodiak section, the *Ibis* at Chignik, the *Merganser* in the Alaska Peninsula region, the *Scoter* on Bristol Bay waters, and the *Tern* on the Yukon River.

The *Petrel* was at Seattle, Wash., pending arrangements for the installation of a new engine. The *Red Wing*, a power vessel approximately 40 feet in length, acquired by transfer from the Department of Agriculture, will be used in the Kodiak region after certain alterations.

An additional vessel for the Alaska service, which has been given the name *Teal*, was under construction at North Bend, Oreg., at the close of the fiscal year 1927. This vessel is to be 78 feet in length and 18 feet in breadth and will have a 150-horsepower full Diesel engine. The *Teal* will be assigned to duty in coastal waters of central Alaska.

APPROPRIATIONS

The regular appropriations for the bureau for the fiscal year 1927 aggregated $1,814,253, as follows:

Salaries, office and field	$688,378
Miscellaneous expenses:	
Administration	3,900
Propagation of food fishes	427,000
Maintenance of vessels	120,000
Inquiry regarding food fishes	57,475
Fishery industries	25,000
Protecting sponge fisheries	2,500
Protecting seal and salmon fisheries of Alaska	340,000
Upper Mississippi River fish-rescue station	25,000
Power vessel for Alaska fisheries	50,000
Nashua (N. H.) fish hatchery repairs	25,000
Establishment of auxiliary stations:	
Georgia	30,000
Colorado	20,000
	1,814,253

Very truly yours,

HENRY O'MALLEY,
Commissioner of Fisheries.

LIGHTHOUSE SERVICE

DEPARTMENT OF COMMERCE,
BUREAU OF LIGHTHOUSES,
Washington, July 1, 1927.

Hon. HERBERT HOOVER,
Secretary of Commerce.

DEAR MR. SECRETARY: In response to your request, I furnish the following report upon the work of the service during the past fiscal year:

MORE IMPORTANT ACTIVITIES OF THE LIGHTHOUSE SERVICE DURING THE YEAR

Lighthouse works of great importance to navigation were under construction or completed during this year. The most important new project undertaken was the building of a primary light and fog-signal station on Lansing Shoal, near the northern end of Lake Michigan, to take the place of a lightship. Important works that were carried well toward completion were the rebuilding of Harbor of Refuge Light Station, the principal signal at the entrance to Delaware Bay; the construction of a light station on Martins Reef, near the north end of Lake Huron, to replace a lightship; a station on Milwaukee North Breakwater; and the enlargement of the important lighthouse depot at Portsmouth, Va. One new lightship was completed, the first to be equipped with a Diesel engine. A river tender was finished and immediately put in service in Mississippi flood-relief work. Two excellent lighthouse tenders were obtained by reconditioning surplus mine planters, and these have been sent to Porto Rico and California for service.

The radiobeacon system was extended during the year by placing 12 additional stations in commission, including the station at Cape Spencer, the first in Alaska, and at Makapuu Point, the first in the Hawaiian Islands. At the end of the year 37 radiobeacons were in operation, and installations are in progress at 17 stations.

An airways division has been set up as a part of the Lighthouse Service, the work of this division covering the examination of airways and emergency landing fields and the erection and maintenance of aids to air navigation. This is one of several divisions established in the Department of Commerce under the air commerce act; it functions under the supervision of the Assistant Secretary of Commerce for Aeronautics. An officer of the Lighthouse Service was appointed chief engineer of the airways division on October 1, 1926, and the work has been actively in progress. As it will be covered more completely elsewhere in the department's report, only brief references to it are included here. The plan followed has been to expand the present facilities and organization of the Lighthouse Service to carry on this work. The geographical organization is

such that it has been necessary to establish only one new office, at Salt Lake City, Utah, the balance of the work being conducted through the existing district and bureau offices and organizations.

At the end of the fiscal year the Lighthouse Service was maintaining a total of 18,363 aids to marine navigation. Although nearly a thousand new aids were established during the year, there was a net increase of only 273, because of the large number of aids discontinued. Of the total aids, 6,577 are lighted and 9,054 are floating.

There were 1,386 miles of airways lighted during the year, on which 139 aids to air navigation were established and placed in operation by the Department of Commerce, and work on 694 miles of additional airways was under contract. The transcontinental airway, with 616 aids, previously maintained by the Post Office Department, was transferred to the jurisdiction of this department on July 1, 1927.

During the year 54 new automatic marine lights on fixed structures were established and 28 lights were changed from attended to automatic. At the end of the fiscal year the total number of automatic lights on fixed structures in commission was 1,203 (not including some partially automatic), and in addition there were 830 buoys with automatic lights, or a total of 2,033 in the Lighthouse Service. There are also 14 fog bells operated automatically.

There was an unusual succession of severe hurricanes and storms during the year. From July to October, 1926, four hurricanes inflicted considerable damage to lighthouse property on the southern coasts.

In April and May the great flood occurred in the Mississippi Valley. The Lighthouse Service with tenders and personnel cooperated in the rescue work under the personal direction of the Secretary of Commerce. The light keepers made a notable record of maintaining the aids to navigation under great difficulties.

An extensive exhibit of the work of this service was made at the Sesquicentennial Exposition at Philadelphia, including lights, fog signals, buoys, etc., giving a comprehensive presentation of the Lighthouse Service from 1716 to 1926. Two medals of honor were awarded for this display.

Many instances were reported where members of the Lighthouse Service effected rescues or aided those in distress. During the year a gold medal was awarded by the Secretary of the Treasury to the master of a lighthouse tender for heroic rescue work.

The commissioner made a brief visit to several of the European lighthouse services and conferred regarding various matters of international and technical interest. Conferences were had as to the need of better facilities for exchange of information and views, and there is prospect of international lighthouse conferences being held at intervals of a few years. Considerable progress is being made in the installation of radiobeacons abroad. There is much discussion of greater uniformity of buoyage and lighting, a problem of importance requiring further study.

AIDS TO NAVIGATION

During the fiscal year there was a net increase of 273 in the total number of aids to marine navigation maintained by the Lighthouse Service. On June 30, 1927, the total number of marine aids was 18,363.

The number of airway aids in commission was 755, including 616 aids maintained by the Post Office Department up to June 30 and transferred to this department July 1, 1927.

Improvements in aids to marine navigation have been made during the year, as follows: 81 fixed lights were changed to flashing or occulting; the illuminant of 7 lights was changed to incandescent oil vapor; the illuminant of 80 lights (including 15 lighted buoys) was changed to acetylene; the illuminant of 13 lights (including 3 lightships) was changed to electric incandescent; 12 radiobeacons were established; 1 gas-operated fog signal was installed at a light station; 7 diaphones and 1 electric siren were established at important stations; and the fog signals at 8 other important stations and lightships were improved by the installation of more efficient apparatus. The discontinuance of aids is under investigation from time to time as the original necessity for their maintenance ceases; 700 aids to navigation of various classes were discontinued during the year.

During the year 41 new aids were established in Alaska, and the total number is now 767, including 284 lights, 19 gas buoys, 1 radiobeacon, 14 fog signals, 290 buoys, and 159 day marks. In 1910 the total number of aids in Alaska was 160.

The first radiobeacon established in Alaska, at Cape Spencer, was placed in commission July 14, 1926.

Beginning March 1, 1927, a system of broadcasting weather reports by radio on four lightships on the Pacific coast was put in effect.

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 commandants by means of allotments made from appropriations for the Lighthouse Service.

ENGINEERING CONSTRUCTION

The more important items of construction completed during the fiscal year were: Riprap foundations for Hart Island, College Point Reef, and Flushing Bay Lights, N. Y.; rebuilding of the north wharf, and tanks and housing for bulk oil storage at the general lighthouse depot, Staten Island, N. Y.; establishing a system of aids to mark the new Delaware & Chesapeake Canal; improvements to the Lazaretto Lighthouse Depot and Lazaretto Light, Baltimore Harbor, Md.; establishing a system of day beacons in Corpus Christi Channel, Tex.; constructing a light and fog signal on the West Breakwater Pierhead, Fairport, Ohio; rebuilding the crib-pier structure at Peach Island Range, Mich.; completing the construction of a light and fog-signal station at Cape Spencer, Alaska; establishing a fog signal at Grays Harbor, Wash., and an unwatched light at Belle Rock, Wash.; establishing and improving aids at seven points in Alaska; and constructing a new type of day beacon on the Florida Reefs. Radiobeacons were established at Thunder Bay Light Station, Mich.; Passage Island Light Station, Mich.; Point Betsie, Mich.; Lansing Shoal, Mich.; Milwaukee, Wis.; Grays Harbor, Wash.; Cape Spencer, Alaska; Makapuu Point, Hawaii; Stratford Shoal, Conn.; also on Portland Lightship, Me.; Cape Charles Lightship, Va.; and Cape Lookout Lightship, N. C.

Other important works in active progress at the close of the fiscal year included the following: Rebuilding the Harbor of Refuge Light Station, entrance to Delaware Bay; rebuilding the bulkhead, south wharf, etc., at Edgemoor Lighthouse Depot, Del.; enlargement and improvement of the Portsmouth Lighthouse Depot, Va.; rebuilding and repairs to various aids caused by hurricane damage in the sixth, seventh, eighth, and ninth lighthouse districts; establishment, improvement, etc., of aids to navigation in Galveston Bay and Houston Channel, Tex.; rearrangement and improvement of aids to navigation in Sandusky Harbor, Ohio; completing and improving the system of aids in Detroit River, Mich.; establishing a light and fog signal at Martins Reef, Mich.; establishing a light and fog signal on outer end of Marquette Breakwater, Mich.; improvements in aids to navigation in the Straits of Mackinac, Mich.; improvements in fog signals at Tawas and Huron Island Light Stations, Mich.; establishing a light and fog signal at Milwaukee Breakwater, Wis.; establishing a light and fog signal at Lansing Shoal, Mich.; establishing five beacons in Dry Strait, Alaska; establishing and improving aids to navigation in Columbia River, Oreg. and Wash.; establishing and improving aids to navigation in Grays Harbor, Wash.; construction of two dwellings at Goat Island Lighthouse Depot, Calif.; constructing wharf and fill at Goat Island Lighthouse Depot, Calif.; rebuilding the wharf at Key West Lighthouse Depot, Fla.; construction of radiobeacons at 17 stations on the Atlantic, Pacific, and Gulf coasts and on the Great Lakes.

IMPROVEMENTS IN APPARATUS AND EQUIPMENT

Work was continued on the installation and use of radiobeacons for the protection of navigation in fog, as stated elsewhere. The use of tube transmitters and of lower power for many stations is being extended. Investigation is being made of the interference between radiobeacons, which sometimes causes difficulty in taking bearings. As respects the clear-weather operation of signals at fixed periods each day, this type of interference has been overcome during the year by introducing a time schedule arranged so that adjacent stations operate at different periods in the day. For operation during fog, a clock-control system is being tried out, to prevent overlap of the sending minutes of adjacent stations; also consideration is being given to separating the frequencies or wave lengths of adjacent stations, and this method is soon to be tested. Much radio-construction work for the service at large was accomplished at the Detroit Lighthouse Depot during the year; about 25 transmitters were built and delivered, and work on about 60 additional transmitters has made material progress. This has been found economical and of benefit in the development of improvements.

An effective type of small acetylene-gas buoy has recently been designed and put in service for use in shallow waters inaccessible to lighthouse tenders. It is light and can be handled by a heavy launch, and it is of quite moderate cost. An efficient launch, which can be carried on the deck of a tender, has been built for handling these small gas buoys. A number of these buoys are already in successful operation.

The substitution of inexpensive iron buoys (special type) for wooden-spar buoys is being constantly extended. These buoys

have great advantages over the wooden spars in being more conspicuous, in permitting distinction of shape for the two sides of a channel and better indication and retention of the color for the same purpose, in being much less destructible by ice and collision, and in not being affected by worms. In the third district in the last six years the number of wood buoys has decreased by 149, or 18 per cent, and the number of iron buoys has increased by 224, or 80 per cent.

The use of gong buoys is being extended where they will be of service in preventing confusion with bell buoys in the neighborhood, and improvements in the gongs are being investigated.

The work of converting oil-gas buoys to acetylene buoys was continued during the year.

Vibratory-disk types of fog signal, operated both electrically and by compressed air, have been tried out in actual service during the past year with good results.

The work of removing old steam fog-signal plants and whistles and replacing them with compressed-air plants and sirens is being extended as rapidly as funds permit. Ten such replacements were made during the year, and there are now only 68 steam plants in service as compared with 131 in 1911.

The extension and improvement of automatic lighting apparatus was continued during the year. The system of two independent automatic light installations for increasing the reliability of more important unattended lights, mentioned in the last annual report, has been developed to a stage where it will be tested at an important isolated light station. The use of double pilot burners for unwatched acetylene lights for the purpose of reducing extinguishment has proved successful and is being extended. A method of automatic control of compressed-acetylene tanks at unwatched stations, whereby but one tank of a battery will be in service at a time, has been developed and is being tried at an important unwatched isolated light on the Pacific coast.

The policy has been continued of converting minor lights in certain localities from oil or incandescent oil vapor to acetylene and having them cared for in groups, increasing their efficiency and reducing the cost of maintenance.

The use of electric current for illumination, both commercial and that generated at the stations, has been extended during the year, a number of lights using either oil, oil vapor, or acetylene having been converted to electric, for the reason that commercial current is now available or that the introduction of radiobeacons makes it practicable and economical to make the change.

A new type of day beacon has been installed on the Florida Reefs. This consists of a solid wrought-iron pile driven into the coral reef, with its head about 2 feet above water; to this is fastened a wrought-iron socket into which is stepped a wooden column with day mark; this foundation pile will not be destroyed if the day mark is carried away.

A quadruple-mouth cast-iron horn was developed during the year for replacing the old copper mushroom horn used on one of the lightships, increasing range of audibility and reducing the noise of the siren on the ship itself.

The installation of tanks at light stations for storage of kerosene in bulk was extended during the year.

A loose-leaf sketchbook showing various apparatus in use in the service has been continued and extended, and this is now being arranged so that it can be used in connection with the price list of standard articles when ordering.

On June 30, 1927, 330 light stations were provided with telephone communication.

The development of improved airway apparatus and structures has been accomplished. The 24-inch rotating airway beacon has been improved by the addition of flashing mechanism for identifying lights, using the motor of the beacon for the driving mechanism, thereby synchronizing the supplementary lights with the flash of the beacon. An improved and reliable lamp exchanger has been developed commercially for airway beacons. Airway structures have been numbered on a mileage basis for identification of location with respect to the airway. This numbering system has been incorporated in the lighting system in order that the distinctive characteristic may identify location of the beacon. The standard airway tower has been improved so as to be entirely suitable for the purpose. A flashing electric beacon, using a 360° Fresnel lens and top section showing from the horizon to the zenith and designed in such a manner that equal candlepower is visible to the pilot approaching the light, has been developed and is now being tried out on the Los Angeles-Salt Lake Airway Beacon No. 6. Astronomic time clocks have been introduced for the control of automatic airway lights. Improvements have been made in the design of the internally lighted wind cone, making the device more reliable and eliminating the slip rings carrying current to the lights. The first commercial installation of radio range beacon has been installed at Hadley Field.

ADMINISTRATION

The organization was changed by the setting up on October 1, 1926, of an airways division, the appointment of a chief engineer of this division, and the expansion of various units to provide for this work as mentioned in the introduction of this report.

Work in connection with airways aids has been assigned to lighthouse districts as follows: Third district, from Boston to New York, and New York to Bellefonte, Pa.; tenth district, from Bellefonte to Bryan, Ohio; twelfth district, from Bryan to Omaha, Chicago to St. Louis, and Chicago to Dallas; and eighteenth district, from San Francisco to Reno, Los Angeles to Salt Lake City, and Los Angeles to San Francisco and Redding. An additional office was established at Salt Lake City for the territory from Omaha, Nebr., to Reno, Nev., Salt Lake City to Pasco, Wash., and Pueblo, Colo., to Cheyenne, Wyo.

The work accomplished during the fiscal year and the statistics furnished, as stated herein, cover only the marine branch of the Lighthouse Service, except where airways work is specifically mentioned. Complete statement covering the progress made in airways lighting, etc., will be found in another portion of the report of the department.

Systematic inspections of the service, both on its technical and its business sides, were continued during the year. The superintendent on general duty made general inspections of stations, vessels, depots,

etc., and the examiner made examinations of the office business methods and accounts, depot stores, and other property records, etc., in various lighthouse districts. Special inspections were made by the commissioner and other officers from Washington.

In the interest of good organization and efficiency, and in conformity with the present general practice in Government engineering work, a corps system of lighthouse engineering designations was put into effect in January, 1927, affecting the district superintendents and their assistants. These officers are now grouped in various grades, as senior, associate, assistant, junior lighthouse engineer. One of these is the superintendent of each district, and the senior assistant is designated as assistant superintendent.

Various economies in the maintenance of the service have been effected, the most important, as already mentioned, being the introduction of automatic apparatus and the grouping of minor lights. Other economies have resulted from the installation of kerosene tanks at light stations and depots, the purchase of illuminating oil locally in bulk and improved methods of its delivery to light stations by the various districts, and the discontinuance of aids to navigation found to be no longer necessary.

There has been effective cooperation with other branches of the Government in many ways, and the personnel on vessels and at stations are encouraged to render aid to those in distress. Cooperation with local school authorities has aided in providing school facilities for the children of light keepers at isolated light stations.

A valuable site and building for district headquarters at Detroit, Mich., was transferred to the Lighthouse Service by the Public Health Service on September 23, 1926. This not only provides office quarters close to the Detroit lighthouse depot, but saves rent.

The Regulations for the Lighthouse Service were revised, reprinted, and issued to the service, effective July 1, 1927, extensive changes having been necessitated by legislation and other causes. The Instructions to Employees have also been revised and are being reprinted.

The total appropriations for the maintenance of the Lighthouse Service for the fiscal year 1927 were $9,269,880 and for special works were $834,601, as compared with $9,032,980 and $725,000, respectively, for the fiscal year 1926. These amounts are exclusive of appropriation for airways, which amounted to $300,000 for 1927, and which was the first appropriation made this department for airway aids.

A cost-keeping system based on actual expenditures for the various features, including direct purchases and articles issued from depot stock, was continued in effect throughout the fiscal year. A stock record was also maintained. This system is found useful in preparing estimates, planning work, effecting economies, and comparing relative efficiency of the various districts, vessels, light stations, apparatus, methods, etc.

PERSONNEL

On June 30, 1927, there were 5,926 persons employed in the marine service of the Lighthouse Service (including some vacancies in authorized positions). There was a decrease of 44 in the number of light keepers and lamplighters, made possible by automatic installa-

tions and by combining the care of larger groups of lights. The net increase of 46, as compared with last year, was due chiefly to temporary employment of laborers and mechanics on field construction work at the close of the year. The number of persons employed in the airways division at the close of the year was 134, making a total number of 6,060 for both marine and airways on June 30, 1927.

The last annual report of the United States Employees' Compensation Commission gives the number of reported cases of injury subject to compensation for the calendar year 1925, of employees of the Lighthouse Service, sustained while in the performance of duty, as follows: Cases resulting in death, 6; cases resulting in permanent total or partial disability, 13; and of temporary total disability, 137. The number of casualties reported indicates the hazardous nature of the field work of the Lighthouse Service. Medical treatment by the Public Health Service, without charge, was received by approximately 1,575 employees of the Lighthouse Service during the year.

Legislation of much value to the personnel, enacted by Congress toward the close of the preceding fiscal year, was put in effect during the year. Besides the special legislation mentioned, general enactments included an increase by the act of July 3, 1926, in the maximum annuity under the civil service retirement law of May 22, 1920.

Incidental to the regular work of the service, many opportunities arise for rendering aid to those in distress, because of the location of the light stations and vessels. During the fiscal year upward of 86 instances were reported of saving life and property or rendering valuable aid, often at a great risk to the lighthouse employees. Many of these acts were especially meritorious, and in such cases the employees were individually commended by the Secretary of Commerce.

A gold medal was awarded by the Secretary of the Treasury to Capt. Norman C. Manyon, in recognition of his gallant conduct on the occasion of the rescue in San Juan Harbor, P. R., described in the last annual report. The medal was presented to him by the Secretary of Commerce on April 13, 1927.

The officers and crew of the lighthouse tender *Columbine* rendered valuable assistance in the case of the grounding of the Cunard steamer *Franconia*, entering San Juan Harbor, P. R., on December 26, 1926.

The keepers of Heceta Head Light Station, Oreg., were commended by the Secretary of Commerce for heroic conduct in the rescue and first-aid treatment, in the face of great personal risk, of a young man who had fallen over a cliff 80 feet to the rocks below and was seriously injured. The scene of the accident was 2 miles from the light station and for about 1,500 feet had to be reached at night by a narrow trail 8 to 12 inches wide, at an average height of 300 feet above the surf and rocks.

LIGHTHOUSE DEPOTS

The lighthouse depots, which are very essential for the efficient conduct of the work, are generally well distributed along the coasts, but several of them are not adequate for the work or are not conveniently located.

During the year many improvements were made at various depots of which only the most important are mentioned. At the general

lighthouse depot, New York, part of the north wharf was rebuilt and new bulk oil storage tanks were installed. At Edgemoor Depot, Del., extensive work is under way. At Portsmouth Depot, Va., the extensive work of enlargement and improvement was practically completed. At Key West Depot, Fla., rebuilding the wharf was actively under way. At Tongue Point Depot, Oreg., extensive dredging was done for this service by the War Department. At the depot located on Goat Island, Calif., two dwellings for the use of keepers were begun.

Provision is needed for improved depot facilities in several districts. Better depot facilities are necessary in the first district, particularly at Portland, Me. At the general lighthouse depot, Staten Island, N. Y., the present machine shop should be extended and new storehouses provided. A more centrally located depot is needed at New Orleans, La. Modern warehouses and shops are needed at Goat Island, Calif., to replace the present buildings. Enlarged buildings, wharves, etc., are needed at Honolulu, Hawaii.

A fire of unknown origin occurred in the lumber shed at the general lighthouse depot on April 30, 1927, resulting in a property damage amounting to about $18,500.

VESSELS OF THE LIGHTHOUSE SERVICE

REPLACEMENT OF VESSELS

The Lighthouse Service at the end of the fiscal year had in commission a total of 114 vessels. Under normal conditions of service a number of these should be replaced each year. At the present time the number requiring replacement is greater than it should be ordinarily because of vessels having been kept in service beyond their normal period of economical use and safe maintenance.

It is expected that two tenders now under construction will replace the *Oleander* and the *Daisy*, and three lightships soon to be contracted for will replace lightship *No. 70*, San Francisco, Calif.; *No. 52*, Fenwick Island, Md.; and *No. 68*, Fire Island, N. Y. Plans are being prepared for the construction of a tender to replace the *Water Lily*. Funds are available for the three lightships, but not for the tender.

A careful survey of the condition of the vessels of this service shows that, in addition to the above, nine lightships and four tenders should be replaced within two or three years, and some of these as early as practicable. These are given in the following list: Savannah lightship *No. 1*, sixth district; relief lightship *No. 5*, second district; Umatilla lightship *No. 67*, seventeenth district; Handkerchief lightship *No. 41*, second district; Scotland lightship *No. 69*, third district; Portland lightship *No. 74*, first district; Cross Rip lightship *No. 66*, second district; Bartlett Reef lightship *No. 13*, third district; relief lightship *No. 16*, third district; new tenders to replace tender *Pansy*, third district, and tender *Water Lily*, sixth district; and new hulls for the tender *Woodbine*, fourth district, and tender *Laurel*, fifth district.

LIGHTHOUSE TENDERS

Lighthouse tenders during the year have steamed a total of 512,084 nautical miles, or an average of approximately 8,700 miles for each tender, in the various maintenance, construction, and inspection work. The total quantity of fuel consumed by tenders during the year was 49,477 tons of coal, 79,388 barrels of fuel oil, 36,169 gallons of gasoline and 3,960 gallons of kerosene. The total cost of maintenance of tenders during the year amounted to $2,257,937, exclusive of repairs, which cost $364,032.

The work of reconditioning two tenders, the *Acacia* and *Lupine*, formerly mine planters, was completed in April, 1927, and the tenders placed in service, the *Acacia* being sent to Porto Rico, replacing the *Columbine*, and the *Lupine* to California by way of Panama, replacing the *Madrono*.

The new tender *Wakerobin*, for the upper Mississippi River, was completed and placed in service April 15, 1927, replacing the tender *Dandelion*. Work in converting the tender *Manzanita* to an oil burner was in progress.

The construction of the tender *Willow*, for the lower Mississippi River, and of the small tender *Beech*, for the third district, was nearly completed. Contract has been let for a 35-foot buoy-patrol boat for the third district.

A small vessel was purchased from the War Department for use as a tender for patrol work, etc., in the eleventh district, was renamed *Thistle*, and placed in service.

At the end of the fiscal year 15 tenders were equipped with radiocompasses, an increase of 2, and 32 with radiotelegraph, an increase of 2.

The old tender *Columbine* was condemned and advertised for sale and the same disposition is proposed for the *Madrono*.

The following tenders have been extensively overhauled during the fiscal year: *Hibiscus*, *Tulip*, *Speedwell*, *Cypress*, *Mangrove*, *Magnolia*, *Sunflower*, *Manzanita*, and *Kukui*.

The following was the number of tenders of the Lighthouse Service on June 30 of the years specified, omitting 2 tenders indefinitely laid up and those not having regular crews: 1910, 51; 1915, 45; 1920, 55; 1925, 55; 1926, 56; 1927, 57. There are 10 small depot tenders without regular crews. On June 30, 1927, 55 tenders were in actual service. Two were undergoing repairs.

LIGHTSHIPS

Lightships are maintained on 45 stations. One additional station off Barnegat, N. J., will be established August 15, 1927. During the fiscal year 56 lightships were in commission, of which 11 were relief ships. They averaged 266 days on station per vessel. The total cost of maintenance of lightships during the year was $1,098,713, exclusive of repairs, which cost $211,900.

The new Diesel-engine lightship *No. 111* was completed and placed in service December 20, 1926, on Northeast End, N. J.; this is the first of this service with Diesel engines.

On the completion of the new lighthouse at Martin Reef, Mich., eleventh district, lightship *No. 89*, marking that station, was released June 7, 1927, and transferred as a relief to the twelfth district.

Scotland lightship *No. 11*, the oldest in the service, permanently relieved last year after 72 years of service, was sold April 7, 1927.

The following lightships have been extensively overhauled during the last fiscal year: *No. 44*, *No. 54*, and *No. 81*.

The following was the total number of lightships on June 30 of the years mentioned: 1910, 68; 1915, 66; 1920, 62; 1925, 59; 1926, 56; 1927, 57. Lightship stations: 1910, 51; 1915, 53; 1920, 49; 1921, 49; 1922, 49; 1923, 47; 1924, 47; 1925, 46; 1926, 46; 1927, 45.

Of the present lightships, 43 have self-propelling machinery and 13 are provided with sail power only; 1 has no means of propulsion.

Very truly yours,

GEORGE R. PUTNAM,
Commissioner of Lighthouses.

COAST AND GEODETIC SURVEY

DEPARTMENT OF COMMERCE,
COAST AND GEODETIC SURVEY,
Washington, July 1, 1927.

Hon. HERBERT HOOVER,
Secretary of Commerce.

DEAR MR. SECRETARY: In response to your request I furnish the following condensed report upon the work of the bureau during the past year:

HYDROGRAPHIC AND TOPOGRAPHIC WORK

During the fiscal year 1927 hydrographic and topographic surveys were made on various sections of the Atlantic and Pacific coasts of the United States, along the coast of Alaska, in the Hawaiian Islands, the Philippines, and in Porto Rico. To perform these surveys, 28 different surveying groups were in the field during the year. Several of these groups worked from shore bases in certain localities where a comparatively small amount of work was required to show natural changes or improvements occurring since the previous surveys. This work was performed in order to have the latest information before compiling new editions of charts of these places.

The ships of the survey, operated by the largest percentage of the surveying personnel of the bureau, continued on the basic program for surveying those sections of the various coasts where unsurveyed areas exist or previously published information has been deemed to be inadequate for modern navigational needs.

On the Atlantic coast the progress has been seriously affected since the first of the year by the condemnation of the *Bache* and her withdrawal from field work. Only one of the three remaining ships is capable of extending surveys on the outer coast. The other two must be limited to certain classes of work adjacent to protected waters on account of their small size. Two ships on the Pacific coast, two in Alaska, one in the Hawaiian Islands, and three in the Philippines continued the program previously laid out and effected satisfactory results in clearing up areas alongshore and in waters of those sections.

A geographic arrangement of the hydrographic and topographic surveys accomplished or in progress at the close of the year is listed below.

On the Atlantic coast.—A complete topographic resurvey was made on the south side of Long Island, N. Y., extending eastward from Far Rockaway Inlet to Amityville and Jones Beach. In the same locality, the adjacent waters were sounded eastward from Far Rockaway Inlet to Long Beach and Broad Channel. A search was made for a reported rock off Bristol Ferry, R. I. The revision of the shore line of Raritan Bay, N. J., commenced during the previous year, was accomplished and the completed work extended along the shore of Sandy Hook Bay and around the outer coast of the Hook.

A hydrographic examination was made of Raritan and Sandy Hook Bays and of the various channels in the vicinity of Sandy Hook. Soundings were taken along the outside of the Hook and in False Hook Channel. A special examination was made of the area southeast of Scotland Light Vessel to determine the effect of dumping material towed to this vicinity from New York City. Surveys of Gunston Cove in the Potomac River, and Bogue Sound opposite Morehead City, N. C., were made. The survey of a section of the South Carolina coast, which was finished early in the year, completed the present program along this coast from the northern part of Florida to the north side of Cape Fear. A continuation of the work to the northward was begun with the accomplishment of the topographic revision and inshore hydrography as far as New River, N. C. The triangulation of St. Johns River was carried to Jacksonville.

On the Gulf coast.—At the request of the bureau, aerial photographs of the east and west coasts of Florida where revision surveys are necessary were made by the Army Air Corps and prints received for assembly and compilation. One of the vessels assisted the party engaged on the flights on the west coast.

Hydrographic examinations were made off Indian River, Captiva and Red Fish Passes on the west coast of Florida. A revision survey of Bocagrande, Fla., and vicinity was completed and another survey commenced at San Carlos Bay to cover the approaches to the Caloosahatchee River. A small area off Pensacola, Fla., was finished before the *Bache* was removed from field work. The work in the vicinity of Tampa Bay was carried to completion as far as Anclote Anchorage.

In preparation for topographic and hydrographic surveys of the shoal-water bays, entrances, and the coast of eastern Louisiana, a party established control from the Mississippi River as far west as Caminada Bay and made a reconnaissance westward from that section. Reported shoal soundings in the Gulf of Mexico off Sabine River were investigated.

On the Pacific coast.—A revision of the coastal triangulation was accomplished from San Pedro to Point Hueneme, Calif., and from the Quinault River, Wash., to the Alsea River, Oreg. Revision surveys were made at Rockport, Russian Gulch, and Greenwood, Calif., in Carquinez Strait, and San Francisco Harbor, off the south side of the San Juan Islands, in Port Townsend, Bellingham Bay, and Everett Harbor. Surveys have been continued north and south from the mouth of the Columbia River. The completed work now extends from Cape Meares, Oreg., to Grays Harbor, Wash., and offshore to the 1,000-fathom curve.

Much of the deep hydrography was done by echo sounding and by using radio acoustic ranging for locating ships' positions. The oceanographic work included the collection of bottom specimens, surface and bottom water samples, and temperature observations at the surface and bottom. Triangulation and traverse control for the extension of the work was continued in advance of the hydrography and topography actually accomplished at the close of the year.

A resurvey of Willapa Bar was made in the fall of 1926 to relocate the shifting channels. Surveys were made in the Strait of Juan

de Fuca, south of the San Juan Island Groups, in Bellington Bay, Everett Harbor, Puget Sound, and Port Gamble. A field examination was made of the shores of Juan de Fuca Strait in connection with the publication of a special chart of this region.

In Alaska.—Surveys begun during the previous year in southeastern Alaska were completed in the following localities: Port Alexander, Pybus Bay, Kaigani Strait, and Port Refugio. In various sections of the main ship channels supplemental wire-drag examinations were finished. Additional surveys were completed in Red Bluff Bay, Warm Spring Bay, Tebinkof Bay, Gedney Harbor, Port Lucy, Port Herbert, Deep Cove, Patterson Bay, in Chatham Strait off Cape Ommaney, along Baranof Island from Point Herbert to Point Patterson, and along Kuiu Island from Point Harris to Point Ellis. A base line of second-order accuracy was measured near Killisnoo.

The survey previously inaugurated on the outer coast was extended from Cross Sound to Lituya Bay and offshore for 50 miles to depths of 1,000 fathoms, including the location of all fishing banks in that area. This work completes the original survey of the outer coast of southeastern Alaska. The survey of Shuyak Strait, including Red Fox and Blue Fox Bays, was finished.

At the close of the year additional surveys were in progress in Baldy Bay, Tlevak Strait, Klawak Inlet, Evans Bay, and Drier Bay. The program for extending original surveys along the coast of Alaska west of Prince William Sound was inaugurated with actual work accomplished in the vicinity of Cape St. Elias, Point Elrington, Port Bainbridge, Drier Bay, and in Nuka Bay.

Porto Rico and the Virgin Islands.—The wire-drag examination of the waters adjacent to Porto Rico and the Virgin Islands was completed and detailed surveys were made of the principal roadsteads of Porto Rico for the purpose of publishing large-scale charts. The work in these islands had been completed and the ship was en route to the States at the close of the year.

In the Hawaiian Islands.—The topography of the shore line of Kaula, Niihau, and of Kauai (except for a section of the north side) was accomplished. The hydrography from the shore out to 1,000 fathoms in the area about Kaula, Niihau, and Kauai was finished except for the waters on the north side of Kauai, where work was in progress at the close of the year.

The shore-line analysis of Oahu Island was continued around the southeast coast to Kaneohe Bay. Detailed inshore hydrography over the reefs was done at Diamond Head and from Makapuu Point to Kailua Bay.

In the Philippines.—Original surveys in the Sulu Archipelago were extended to include the group of islands about Pagutarang Island and in the area south of Tawi Tawi Island. A revision survey was made of Manila Harbor.

The survey of the islands and waters north of Luzon Island was resumed upon the cessation of the northeast monsoon. On the east coast of Luzon, work was commenced on extending surveys north of Polillo Island. The triangulation in central Luzon was carried on during the favorable season. Surveys were made along the northwest coast of Mindanao.

Coast Pilot field work.—The following field examinations for new editions of Pilots were completed:

1. Atlantic Coast Pilot, St. Croix River to Cape Cod.
2. Inside Route Pilot, New York to Key West.
3. Philippine Island Pilot, Part I.

Work was begun upon Atlantic Coast Pilot, Cape Henry to Key West.

Hydrography, topography, and triangulation (third order) performed during year

Locality	Hydrography		Topography		Triangulation (third order)		
	Number of soundings	Area in square miles	Length of shore line surveyed in miles	Area surveyed in square miles	Length of scheme in miles	Area covered in square miles	Number of geographical positions determined
South coast, Long Island, N. Y	8,256	29	336	91	5	35	17
Coast of New Jersey	3,495	12	44	20	14	60	20
Potomac River	3,784	3	9	1	3	3	10
Bogue Sound, N. C	1,660	2	18	3	14	16	36
Coasts of North and South Carolina	40,752	1,750	86	20			5
St. Johns River, Fla					25	20	155
Bocagrande and vicinity, Fla	17,744	35	52	10	22	58	12
Vicinity of Anclote River, Fla	25,359	49	66	15	15	25	13
Coast off Pensacola, Fla	3,384	192	43				2
Louisiana coast					46	160	40
Coast of Texas	766	225					
Coast of California					50	270	50
Coast of Oregon					94	185	85
South of Columbia River, Oreg	34,581	2,731	80	22			
Willapa Bar, Wash	3,687	11					
Outer coast of Washington	53,203	3,260	180	118		35	12
Strait of Juan de Fuca, Wash	800	1	13	3		87	13
Puget Sound, Wash	8,599	33	73	28	17	101	59
South of San Juan Island, Wash	5,506	92	3	1		97	34
Southeast Alaska (Chatham Strait, etc.)	16,681	156 wd 126	288	159		30	26
Bays in southeastern Alaska	21,474	50 9	210	84	35	105	82
Coast southeast Alaska	20,112	1,255	202	219	6	484	13
Coast southwest Alaska	7,226	792 wd 8	96	115	80	122	83
Shuyak Strait, Alaska	7,637	43	97	34		72	20
Porto Rico and Virgin Islands	24,553	58 wd 33	68	75	26	106	51
Oahu Island, Hawaii	19,293	15	47			38	22
Hawaiian Islands	42,945	1,501	129	46	45	500	85
Manila Bay, P. I	579	1					
Vicinity of Pangutarang Island, P. I	58,069	1,229	52	13	61	1,022	42
South of Tawi Tawi Island, P. I	70,186	510	127	69		40	6
San Francisco, Calif						11	3
Sanboy Islands, P. I	39,417	304	22	6		102	
Batanes Island, P. I	14,981	2,956	132	101	5	7	5
Sulu Archipelago, P. I	11,298	71	29	4	25	200	4
East coast Luzon Island, P. I					92	3,000	45
Murcielagos Bay, P. I	17,441	62	54	31		46	13
Cap Island, Sulu Archipelago, P. I	5,864	54	4	1			
Northern Luzon, P. I					110 85	1,800 1,500	48 recon.

GEODETIC WORK

	Length of scheme	Area covered
	Miles	*Square miles*
Triangulation, first order:		
Washington, forty-ninth parallel	110	1,800
California and Nevada, Las Vegas-San Luis Obispo	315	10,000
Minnesota and Iowa, ninety-fourth meridian	105	1,040
Georgia, City of Atlanta	25	275
South Dakota and Minnesota, ninety-eighth Meridian-Albert Lea	100	1,225
Total	655	14,340
Triangulation, second order:		
Hawaiian Islands, Island of Oahu	35	100
Triangulation, third order:		
New Jersey, Barnegat Bay	15	45
Pennsylvania and New Jersey, Delaware River	5	15
Maryland, Chesapeake Bay	7	15
Virginia, Arlington County	8	40
Louisiana, Mississippi River-Caminada Bay	50	180
California, San Pedro-Point Mugu	50	320
Oregon, Columbia River-Tillamook Bay	15	45
Oregon, Tillamook Bay-Alsea River	80	175
Total	230	835
Traverse, first order:		
Wisconsin, Green Bay-La-Crosse	200	
Georgia, City of Atlanta	55	
Ohio, Wright Field, Dayton	40	
Total	295	
Traverse, third order: Oregon, Columbia River-Tillamook Bay	7	
Base lines, first order:		
California-Nevada, Pahrump	15	
Georgia, Decatur	2.9	
Georgia, Inman	1.8	
Total	19.7	
Base lines, second order:		
Alaska, Killisnoo	2.4	
Hawaiian Islands, Scofield	2.7	
Total	5.1	
Base lines, third order:		
Louisiana, Grand Isle	3.2	
Oregon, Sand Lake	1.2	
Oregon, Netarts	1.3	
Total	5.7	
Reconnaissance:		
South Dakota and Minnesota, ninety-eighth Meridian-Albert Lea	240	2,600

	Length of scheme	Area covered
	Miles	*Square miles*
Reconnaissance—Continued.		
Minnesota, Albert Lea-Royalton	215	2,600
Maryland, Virginia, West Virginia, Pennsylvania, and Ohio, Pittsburgh Arc	260	3,900
Georgia, City of Atlanta	25	275
Georgia, City of Atlanta, traverse	55	
Ohio, Wright Field, traverse	40	
Hawaiian Islands, Island of Oahu	85	250
New Jersey, Barnegat Bay	15	45
Pennsylvania and New Jersey, Delaware River	5	15
Maryland, Chesapeake Bay	7	15
Virginia, Arlington County	8	40
Louisiana, Mississippi River-Atchafalaya Bay	90	315
California, San Pedro-Point Mugu	50	320
Oregon, Tillamook Bay-Yachats River	90	200
Total	1,185	10,575
Leveling, first-order:		
South Dakota—		
Rapid City-Edgemont	87.3	
Vivian-Loyalton	169.4	
Loyalton-Zeeland, N. Dak	52.0	
California—		
San Fernando-Saugus-Mojave-Saugus	244.0	
San Diego—Yuma	204.9	
LaJolla-San Diego	15.6	
Colorado—		
Salida-Grand Junction	192.7	
Cheyenne Wells-LaSalle	359.0	
Arizona—		
Yuma-Hassayampa	137.5	
Yucca-Gila Bend	206.0	
New Mexico—Vaughn-Logan	126.8	
Massachusetts—Springfield-Boston	110.0	
Territory of Hawaii—		
Hilo-Summit of Mauna Loa	65.0	
Island of Oahu	157.0	
Total	2,127.2	
Summary:		
First-order triangulation	655	14,340
Second-order triangulation	35	100
Third-order triangulation	230	835
First-order traverse	295	
Third-order traverse	7	
First-order base lines	19.7	
Second-order base lines	5.1	
Third-order base lines	5.7	
Reconnaissance	1,185	10,575
First-order leveling	2,127.2	

Of the four projects of first-order triangulation on which work was done during the year, two were completed which were of special importance in that they were the last projects to be included in the readjustment of the triangulation in the western half of the United States. Both projects were very difficult, because of the topography of the regions covered. The first was along the forty-ninth parallel in northern Washington where the mountains are very difficult of access and where forest fires delayed the progress of the party. Five observing parties were used on this project, and the work was done with considerable risk of injury to the men engaged upon it. The other important project was the arc of triangulation extending from Las Vegas, Nev., to San Luis Obispo, Calif., across the desert regions over and south of Death Valley.

The reasons for the readjustment of the first-order triangulation west of the ninety-eighth meridian were given in last year's report. Briefly, the process of adjusting new work into old which had been followed for many years resulted in a gradual accumulation of error to such an extent that, frequently, the errors caused by the adjustment were much larger than those incidental to the field observations and were beginning to be of such magnitude that they could be detected with a good engineer's transit. The change in geographic position of the points along the west coast, caused by the readjustment, will not in any case exceed 140 feet, and this will cause the projection lines on the standard topographic map to be shifted less than one-fortieth of an inch.

With the completion of the general scheme of first-order triangulation in the western part of the country, the greater part of our activities in establishing first-order horizontal control will be transferred during the next few years to the eastern half of the United States. This does not mean that all of the first-order triangulation in the western half of the country is completed, but a gridiron system has been established, with belts of triangulation from 200 to 400 miles apart. Several thousand miles of first-order triangulation must yet be run in the West, but many years of work will be required to establish as effective control in the East as now exists in the West.

Work was begun in the large area including and surrounding Iowa, more than 150,000 square miles in extent, which is entirely devoid of first-order triangulation and traverse. One party ran a line of first-order traverse from Green Bay, Wis., through Wisconsin Rapids to La Crosse. Another party began a north and south belt of triangulation in northern Iowa and in the latter part of the fiscal year a third party began work in South Dakota on an east and west arc which will extend to La Crosse and connect with the northern Iowa triangulation.

This latter party is using the Bilby movable steel tower for triangulation which has been recently devised and which is designed to take the place of the wooden towers formerly erected at stations in level country. The wooden towers had to be abandoned after being used once. The towers used in triangulation in flat country are required to extend to an average height of about 65 feet in order to enable the observer to see over the trees and to counteract the effect of curvature of the earth's surface. The cost of building the wooden towers makes triangulation in level country very expensive.

The results obtained by the party using the steel towers during the last month of the fiscal year indicate that the unit cost of first-order triangulation will be reduced 25 to 35 per cent by the use of the steel towers.

Reconnaissance for first-order triangulation was carried on in two sections of the country during the latter part of the year; the first was on a belt of triangulation extending from the vicinity of Hagerstown, Md., past Pittsburgh, Pa., to a junction with the first-order triangulation of the United States Lake Survey on Lake Erie, near Painesville, Ohio. The other reconnaissance was executed along the route now being followed by the party working in Minnesota and North Dakota.

Work was done on only two leveling projects under our own appropriations. The first line, which was in South Dakota, will later be extended northward to a junction with an east and west level line near Minot, N. Dak. The other level line was run in California and Arizona, partly under the appropriation for control surveys in earthquake regions. These lines in Califronia are designed to cross the major fault zones in that region in order to furnish a means for determining the amount of vertical displacement caused by future earth movements. Lines were run from Saugus to Bakersfield, from Bakersfield to Mojave, and from Mojave to Saugus in the region northward from Los Angeles. In southern California a line was run from San Diego eastward to Yuma, Ariz., and thence to a conneciton at Hassayampa with a line of levels run in cooperation with the United States Geological Survey.

Part of the line from San Diego to Yuma was run through Mexican territory. The consent of the Mexican Government was obtained and a representative of that Government was with the party part of the time. Bench marks furnished by the Mexican Government were set along the Mexican portion of the line by our party.

Five level lines were run during the year in cooperation with other organizations. On four of these projects the United States Geological Survey furnished the money for field expenses while this bureau furnished the observer and the instrumental equipment. Two of these cooperative projects with the Geological Survey were in Colorado, the third in Arizona, and the fourth in New Mexico.

In Massachusetts a leveling party worked on a similar cooperative basis with the Metropolitan District Water Supply Commission of Boston in extending a line of levels from Springfield to Oakdale. The line from Oakdale to Boston, to a connection with existing levels of the Coast and Geodetic Survey, was run with money from our own appropriation.

Cooperation was extended on two other surveys, first with the city of Atlanta in executing horizontal and vertical control over the region surrounding that city and second with the Air Corps of the United States Army in executing first-order traverse near Dayton, Ohio. This traverse will be used by the Air Corps in determining the amount of error in the experimental airplane mapping.

Two field parties were engaged during part of the season on field astronomic and gravity observations. Advantage was taken of the arrangements made by the International Geodetic and Geophysical Union to establish a new world longitude net, and stations at Honolulu and at Manila were connected into the international net. At both

places new astronomic stations were established and both astronomic and geodetic connections were made with the old longitude stations. A few gravity stations were also established in the Philippine Islands. Gravity observations were made on the island of Hawaii at the summits of Mount Kilauea and Mauna Loa Volcanos and at Hilo on the coast. A line of levels was run from the base of Kilauea Volcano to the summit and bench marks were established along the route. It is believed that this work will be of great value to seismologists and volcanologists in their studies of volcanic phenomena.

In the Hawaiian Islands a party, working in cooperation with the United States Army, the Territorial government, and the United States Geological Survey, extended a line of levels through part of the island of Oahu. Later, the same party, in cooperation with the Army and the Territorial government, revised and strengthened the main scheme triangulation over Oahu, and was engaged on this work at the end of the year.

The International Latitude Station at Ukiah, Calif., was operated throughout the fiscal year. In addition to the regular observations, the observer in charge made an investigation of the effect of tilting of the latitude pier on the observed latitude. A paper describing the results will appear in the Astronomical Journal.

MAGNETIC AND SEISMOLOGIC WORK

The magnetic and seismologic work accomplished during the fiscal year was as follows:

The field work consisted in occupation of repeat stations to determine the change in the earth's magnetism, occupation of new stations, and replacement of defective stations from California to Utah and from New Mexico to Arkansas and Missouri. Along the coasts of the United States and in Alaska observations were made at a number of stations in connection with hydrographic work. A number of sites were investigated on the island of Oahu, Hawaii, to determine their suitability for observatory work looking toward a transfer from the present site.

Both magnetic and seismological work was carried on continuously at the observatories at San Juan, P. R.; Cheltenham, Md.; Tucson, Ariz.; Sitka, Alaska; and Honolulu, Hawaii. Additional work of importance included the improvement of the new site in Porto Rico; investigational work at Cheltenham, which is resulting in improved methods and economies at all the observatories and at the Washington office; investigation of a new seismograph at Tucson, which is an essential preliminary to suitable installations at other stations; investigations of aurora and magnetic storms and their relation to radio and cable transmission at Sitka; and the use of a new site at the University of Hawaii, Honolulu, for a seismograph in an attempt to solve the difficulties in connection with the present unsatisfactory site of the magnetic observatory.

TIDE AND CURRENT WORK

In addition to numerous short series of tide observations along the coasts of the United States and possessions in connection with hydrographic surveys, tide observations were continued at primary tide stations of the bureau for the purposes of furnishing general tidal

control for hydrographic surveys in the various regions represented and for the determination of tidal datum planes.

Primary tide stations

Portland, Me.
Portsmouth, N. H. (cooperative).
Boston, Mass.
New York, N. Y. (part year).
Fort Hamilton, N. Y. (part year).
Atlantic City, N. J.
Philadelphia, Pa.
Baltimore, Md.
Charleston, S. C.
Key West, Fla.
Pensacola, Fla.
Galveston, Tex.
La Jolla, Calif.
Los Angeles, Calif. (cooperative).
San Diego, Calif. (cooperative).
San Francisco, Calif.
Astoria, Oreg.
Seattle, Wash.
Ketchikan, Alaska.
Valdez, Alaska.
Seward, Alaska.
Honolulu, Hawaii (cooperative).
Hilo, Hawaii (part year).

Tide observations, secondary stations.—In addition to the primary stations, short series of tide observations were made at 142 secondary stations in connection with hydrographic work, these records totaling 16 years 8 months.

Tide observations, outside sources.—Tide records were received from sources outside this bureau from 16 tide stations, totaling 9 years 8 months of record.

Following is a brief summary of all tide records for the full fiscal year from all sources:

Summary of tide records received

	Stations	Years	Months
Eastern coast	38	13	5
Gulf coast	14	4	1
Pacific coast	20	8	6
Alaskan coast	14	4	3
Outlying territory	23	11	7
Total	109	41	10

Current observations.—During the year current observations were made on Diamond Shoals and Boston Light Vessels. In addition, short series of current observations were made at a number of stations as listed in the summary below.

Summary of current observations received

	Stations	Years	Months
Light vessels	2	2	
Short series	146	1	2
Total	148	3	2

The currents in San Bernardino Channel, Philippine Islands, are strong and vary considerably. In order to furnish the mariner accurate predictions for this important waterway, one month of current observations were made near the end of the last fiscal year by

the party on the steamer *Fathomer*. These observations were analyzed at this office and predictions made and issued as a supplement to the Pacific Coast Current Tables for the calendar year 1927.

During the year the current and tide survey of Boston and Portsmouth Harbors, begun near the end of the last fiscal year, was completed. This work extended over a period of three months and covered observations at 90 current stations and 15 tide stations.

At the close of the current survey of Portsmouth Harbor a subparty from this party connected by spirit levels the tidal bench marks at Stonington, West Mystic, New London, Neantic, New Haven, and Milford, Conn.

The tide station at Daytona Beach, Fla., destroyed by a storm on July 27, 1926, was reestablished in June, 1927. Funds for the reestablishment of this station were made available in the first deficiency bill.

This bureau cooperated in the maintenance of tide stations at Portsmouth, N. H., Jamaica Bay, N. Y., Los Angeles, Calif., San Diego, Calif., and Honolulu, Hawaii, and arrangements are being made for the establishment, soon after the beginning of the next fiscal year, of a cooperative tide station at the naval operating base, Hampton Roads, Va.

The tide station at Cape May, N. J., having fulfilled the purposes for which it was established, was discontinued December 31, 1926.

Tide stations were established at the following places during the year: Portsmouth, N. H.; New York (Battery), Fort Hamilton; Hilo, Hawaii; and three in Jamaica Bay, N. Y. The stations at Portsmouth and in Jamaica Bay are cooperative stations.

Temperature and density observations, frequently requested by operators of cold-storage plants, by fishing concerns, and by investigators of the ravages of pile-boring limnoria, were made at all primary tide stations maintained by the bureau at no increased cost. Short series of these observations were also made at all current stations occupied in Boston and Portsmouth Harbors by that current survey party.

The following cooperation was given this bureau in tidal work during the year:

The Navy cooperated in the establishment and maintenance of tide stations at the navy yard, Portsmouth, N. H., and at San Diego, Calif.

Capt. G. St. Maur Stocker, Swatow, China, is furnishing the records from a series of tide observations being obtained at the entrance to Swatow Harbor.

The chief hydrographer, Canal Zone, furnished tide observations for the full year at two stations in the Canal Zone.

The district engineer, United States Army, Wilmington, Del., obtained for this bureau three-month series of tide observations in the Maurice and Cohansey Rivers.

The city of Los Angeles and the Territory of Hawaii are cooperating in the maintenance of tide stations at Los Angeles and Honolulu, respectively.

WASHINGTON OFFICE

The organization of the Washington office has remained substantially the same as during the preceding fiscal year.

CHIEF CLERK

The principal duties of this division are the care, custody, and upkeep of the buildings occupied by the bureau; the supervision of the expenditures for office expenses, including the purchase of supplies for the office, for chart printing work, and to some extent for the field; the care of most of the original records of the field surveys, as well as the library of printed publications; the general supervision of all matters relating to the personnel work, including reports of leaves of absence; the custody and accounting for the receipts from the sale of charts, publications, etc.; and the direction of the engineer, electrician, watch, messenger, labor forces, and other employees engaged in the care, maintenance, and protection of the buildings occupied by the bureau in the District of Columbia.

Cooperation with the division of terrestrial magnetism and seismology in stimulating interest of county surveyors and civil engineers in the inspection and maintenance of the magnetic stations already established by the bureau has continued throughout the year.

In the library and archives 134 hydrographic and 96 topographic sheets, each representing new surveys made by the bureau, were received. Other additions were blue prints (mostly showing surveys made by Army Engineers), 676; maps, 1,569; charts, 1,891; field, office, and observatory records, 4,019; photographs and negatives, 274; prints, 264; lantern slides, 165; books, 441.

The total number of permanent and temporary employees in the office and field forces, which includes commissioned officers and all employees appointed through civil-service certification is, office force, 201; field force, 203; total, 404. These figures do not include the persons engaged as rodmen, chainmen, heliotropers, and others in the field parties nor any enlisted men on vessels.

The statistics in regard to leave of absence during the calendar year are, annual leave, 7,684 days; sick leave, 2,304 days; without-pay leave, 609 days; and accrued leave, 3,017 days. While the number of employees naturally varied on account of resignations and vacancies, calculated on the number actually in the service on June 30, 1927, as a basis of computation, the average annual leave taken during the year by each employee was approximately 19.02 days, and sick leave 5.70 days.

The receipts from the sale of charts and nautical publications prepared by the bureau amounted to $58,973.63, and the funds realized from the sale of old property, work done, and miscellaneous sources amounted to $9,003.23.

DIVISION OF HYDROGRAPY AND TOPOGRAPHY

This is the division of ship surveys. It has charge of the work of all of the survey ships and practically all of the smaller parties using floating equipment. Regular and routine duties comprising the preparation of instructions, review of field work, the allotment of funds, maintenance of equipment, and party personnel matters require most of the time of the personnel of the division.

However, considerable effort has been given to improvement in operations and equipment. Investigations and research into the problems of radio acoustic ranging and in echo sounding have been made. Two additional ships have been equipped for echo sounding and three radio direction finders installed. Several portable radio outfits for use in maintaining communication between a ship and its detached launch parties have been placed in operation, and a small motor-driven sounding machine for launch use was designed and is being built. Plans and specifications for a watchman's house at the Ketchikan, Alaska, boathouse, and also for extensive alterations to the hull and machinery of two 40-foot Navy steam launches were prepared. Two sets of preliminary plans for a new Diesel electric ship of approximately 600 tons displacement have been made.

The newly organized training section, whereby officers entering the service are given short intensive instructions in ship and field work, has been maintained throughout the year with good results.

Considerable progress has been made in bringing up to date the various coast and inside route pilots. At present they are in quite a satisfactory condition, the average age of the pilots having been reduced from 5 years and 2 months to 3 years and 7 months. New editions of the following pilots were issued:

Atlantic Coast Pilot, Cape Cod to Sandy Hook.
Pacific Coast Pilot.
Alaska Pilot, Part II.
Inside Route Pilot, New York to Key West.
Inside Route Pilot, Coast of New Jersey.

The usual annual supplements to all Coast Pilots for which new editions were not in print were compiled and issued. Work on a hydrographic and also a topographic manual has begun.

DIVISION OF GEODESY

The following important pieces of work were completed during the year or were in progress at the end of the fiscal year:

Computation and adjustment of triangulation and traverse—

1. Readjustment of first-order triangulation west of the ninety-eighth meridian.
2. Southeast Alaska.
3. Along the Delaware and Schuylkill Rivers from observations by the United States Engineers.
4. Barnegat Bay, N. J., field work executed by the Engineering Conservation Commission of New Jersey.
5. Rockaway Beach, N. Y.
6. Arlington County, Va.
7. Puget Sound.
8. Ukiah latitude station connection.

Computation of base lines—

Pahrump, California-Nevada.
Decatur, Ga.
Inman, Ga.
Point Gustavus, Alaska.
Killisnoo, Alaska.

Computation of first-order traverse—Green Bay to La Crosse, Wis.
Computation of lines of first-order leveling—

1. Burbank-San Pedro, Calif.
2. Rapid City-Edgemont, S. Dak.
3. Salida-Grand Junction, Colo.
4. Vivian-Loyalton, S. Dak.
5. Cheyenne Wells-La Salle, Colo.
6. Saugus-Bakersfield - Mojave - Saugus, Calif.
7. San Diego, Calif.-Yuma, Ariz.
8. Yuma-Hassayampa, Ariz.

Computation of astronomic work—

1. Azimuths: Twenty-nine stations in the western part of the United States and in Alaska.
2. Longitudes: Two stations in the western part of the United States. Computations are in progress for the two world longitude stations at Honolulu and Manila.
3. Latitudes: Sixteen stations in the western part of the United States and in Canada near the forty-ninth parallel boundary.
4. Computation of true geodetic azimuth at two Laplace stations.
5. The computation of the reduction for topography and isostatic compensation for 1 station in the United States, 4 stations in the Hawaiian Islands, and for 90 stations at sea determined on a submarine by Dr. F. A. Vening Meinesz, of the Netherlands. The sea stations are in the Mediterranean Sea, Atlantic Ocean, Caribbean Sea, and Pacific Ocean and were nearly all established on Doctor Meinesz's recent trip to Java by way of the Panama Canal.
6. An investigation to determine the approximate depression of the geoid in the deep part of the Atlantic Ocean directly east of Charleston, S. C.
7. A computation to determine the average isostatic anomalies for a number of equal-area sections of the United States.

Other investigations were carried on during the year in the following subjects: Interior of the earth; variation of latitude; California earthquake.

The following publications were issued by the division during the fiscal year:

Serial 356. Use of the gravity pendulum as a timepiece.
Serial 366. Isostatic condition of the United States as indicated by groups of gravity stations.
Special publication No. 65, Serial 368. A new and completely revised edition of Instructions to light keepers on first-order triangulation.
Special publication No. 130, Serial 378. Tables for Albers projection.

The following were in press at the close of the fiscal year:

Special publication No. 134. Geodetic operations in the United States, January 1, 1924, to December 31, 1926.
Special publication No. 137. Manual of first-order traverse.

DIVISION OF CHARTS

The demand for our charts and other publications continued to increase during the year, as is evidenced by the figures already given, showing the total issue and condemnation of charts and issue of Coast Pilots, Tide and Current Tables, and other publications sold for a price.

The figures for 1927 are the largest of any year since the war, when, of course, the demand for our products was unprecedented. The task of keeping the charts in print so as to be able at all times to meet this increased demand without printing large supplies which would result in excessive condemnation as new information was received, has been one to which this office has given constant and careful study, with the result that the condemnation, never large, was last year below the average for the five-year period ending June 30, 1927.

Reconstruction of the following charts will be undertaken during the coming fiscal year, and such progress will be made as the situation permits:

No. 295. Delaware River—Wilmington to Philadelphia.
No. 954. Panama Canal and approaches.
No. 1001. Chesapeake Bay to Straits of Florida.
No. 4108. Hanapepe Bay.
No. 4112. Hanamaulu Bay.
No. 5535. San Francisco Bay, Visitation Point to Point Bluff.
No. 6300. Georgia Strait and Strait of Juan de Fuca.
No. 8218. Pybus, Hobart, and Windham Bays.
No. 8701. Morzhovoi Bay and Isanotski Strait.

Insertion of the following plans on existing charts:

No. 1226. Black River.
No. 5602. Rockport Landing.
No. 5703. Russian Gulch Landing.
No. 5703. Greenwood Landing.

DIVISION OF TERRESTRIAL MAGNETISM AND SEISMOLOGY

Magnetic work.—Chief consideration has been given to making the accumulated information available for the use of the public. Although on account of insufficient personnel much material remains unpublished, continued development of new methods and instruments has made it possible to make some progress on work that had previously been stopped, and has helped to reduce the quantity on hand of the results which are steadily being obtained from the observatories.

Magnetic information has been in constant demand from local surveyors, and there has been continuous support of the efforts to determine by correspondence with them and others the present condition of magnetic stations used in correcting the surveyor's instruments so that better surveys may be made. By the end of the next fiscal year the condition of most of the magnetic stations in the United States will be known. Those who are using magnetic methods in the search for oils and minerals have made frequent use of the magnetic stations, magnetic observatory results, and magnetic publications; investigators of the difficulties of radio transmission have utilized the magnetic records of the bureau; assistance has been given to universities establishing courses in geophysics which included work in terrestrial magnetism; and other Government bureaus, private institutions, and electrical companies have benefited from this bureau's work.

The program of modernizing the instrumental equipment has gone on steadily, and as a result of the cooperation of the instrument division, most of this equipment is in excellent condition at a very moderate cost.

The progress of the campaign to get in touch with local surveyors has now reached the point where the bureau is in contact with surveyors or local organizations throughout the country. The condition of 243 stations were reported by them during the fiscal year of 1927, leaving about 1,250 marked stations whose condition is unknown.

Effective cooperation has been maintained with the Colorado School of Mines, the Carnegie Institution of Washington, and various commercial organizations.

Members of the division have taken part in the activities of the American Geophysical Union and the International Geodetic and Geophysical Union, and have held office in these organizations.

Since the work of the bureau bears a definite relation to national and international activities in the same subjects, close contact with those interested in the work is important to avoid overlapping or omission of important functions.

The following publications were issued during the year:

Magnetic Declination in the United States for 1925, including isogonic maps for the United States for January 1, 1926.
Results of Magnetic Observations in 1925.

The following publications were in the hands of the printer at the close of the fiscal year:

Magnetic Declination in California and Nevada in 1926.
Observatory Results for Cheltenham, Md., 1923–24.
Results of Magnetic Observations made in 1926.
Progress in Terrestrial Magnetism in the United States 1926–27.

The following publications were in preparation:

Magnetic Declination in Texas in 1927.
Magnetic Tables and Charts for 1925.

Seismology.—The principal aim has been to collect and publish in convenient form all information regarding earthquakes occurring in the United States and the regions under its jurisdiction. The information has come partly from reports of those experiencing the earthquake, and the continued cooperation of the Weather Bureau in securing such reports from its observers has aided greatly. In addition special cooperation is being organized in parts of the country most likely to be affected by earthquakes. As instrumental information is necessary, the results from the five observatories of the bureau, the station at the University of Chicago now operated by this bureau, and contributed data from various organizations and educational institutions help to make the information complete.

The publication is in very useful form but it is unavoidably about nine months behind a proper schedule of publication, and some of the discussion of earthquakes is inadequate, through the lack of sufficient personnel.

A comprehensive study was made of the Wood-Anderson torsion seismograph at Tucson, Ariz., in order to eliminate minor defects and bring out the full usefulness of this instrument. A number of seismologists aided by advice in this investigation.

The seismological reports are being issued, though behind schedule. Those for the second half of 1925 were issued during the year. The one for the last quarter of 1925 contained a supplement for the last half of 1924, the period between the cessation of publication by the Weather Bureau and the taking up of it by this bureau. It also contains maps showing the location of all earthquakes occurring in the United States in 1924 and 1925.

The following publications were in the hands of the printer at the close of the fiscal year:

Seismological Report, first quarter, 1926.
Progress of Seismological Investigations in the United States, 1925–1927.

The following publication was in preparation:

Principal Earthquakes of the United States.

There has been cooperation with a number of organizations interested in the study of earthquakes.

DIVISION OF TIDES AND CURRENTS

Although the office work required of the division of tides and currents has increased considerably in the past few years because of the additional data from the tide and current surveys of harbors, without a commensurate increase in the personnel, the schedule for the predictions of tides and currents and preparation of the annual tide and current tables has been maintained. The predictions are made and the manuscript submitted to the Government Printing Office each year in time to have all the tables for any calendar year ready for issue by July 1 of the preceding calendar year. Tide predictions for the tide tables for the calendar year 1929 were begun November 4, 1926, and completed February 16, 1927. Predictions of currents for the current tables for the calendar year 1929 were begun February 17, 1927, and completed April 30, 1927.

The following table, showing the issue of the tide tables for each fiscal year for the 10-year period 1917–1926, is indicative of the usefulness of the tables:

	United States and foreign ports tide tables	Atlantic coast tide tables	Pacific coast tide tables	Total
Tide tables for fiscal year—				
1917	1,598	3,852	13,346	18,696
1918	3,334	3,970	14,492	21,796
1919	4,217	4,398	14,768	23,383
1920	3,469	5,357	16,061	24,887
1921	3,577	5,678	14,957	24,212
1922	3,067	5,704	14,902	23,673
1923	2,479	5,440	15,054	22,973
1924	2,509	7,097	15,234	24,840
1925	2,218	6,727	15,849	24,794
1926	2,730	6,707	15,347	24,784

In addition to the tables issued by this bureau a large number of privately printed tables for various localities are issued all over the country. The public also receives the benefit of these predictions through the daily newspapers, almanacs, and calendars. The private tables are copied directly from the Government tide tables and due credit is given for the source of the data.

The following table shows the number of copies of the current tables issued for the fiscal years 1923 to 1926, separate current tables having been issued in 1923 for the first time:

	Atlantic coast current tables	Pacific coast current tables	Total
Current tables for fiscal year—			
1923	2,029	1,786	3,815
1924	3,124	2,002	5,126
1925	2,452	2,474	4,926
1926	3,014	1,763	4,777

In order that the observations dealing with tides and currents can be reduced systematically and the results made available in the most economical manner to the mariner, engineer, and public generally, it has been the aim during the year to arrange the regular routine work so as to give as much time as possible to the interpretation of these data and the preparation of publications containing the important data accumulating in the files. Accordingly several special publications were prepared.

Special Publication No. 123, Tides and Currents in Delaware Bay and River, was received from the printer in August, 1926. This is the third of a series which is to cover all the important waterways of the country.

Special Publication No. 124, Instructions for Tidal Current Surveys, was received from the printer in November, 1926. This publication furnishes descriptions of the instruments used and detailed instructions for conducting current surveys.

Special Publication No. 128, Tidal Bench Marks, State of Rhode Island, was received from the printer in February, 1927.

Special Publication No. 127, Tides and Currents in Southeast Alaska, was received from the printer in March, 1927. This publication is the fourth of the series of similar publications dealing with tide and current observations in the important waterways of the United States and possessions.

The manuscript for a special publication entitled "Tidal Datum Planes," was sent to the printer in June, 1927. This gives a full discussion of the principles and methods involved in the determination of tidal datum planes.

The manuscript for a special publication, Tidal Bench Marks, State of Connecticut, was sent to the printer in June, 1927.

The observations obtained on the current and tide survey of Boston and Portsmouth Harbors have been reduced during the fiscal year and the manuscripts of special publications prepared on tides and currents in these harbors for printing next fiscal year.

The cooperative arrangement has been continued and extended during the year with the British Admiralty, the Canadian Government, and Deutsches Seewarte whereby manuscripts for American tide predictions are exchanged for predictions by those organizations. This exchange began several years ago with the British Government in the exchange for 5 ports and has since been extended to a present exchange of 26 ports.

DIVISION OF ACCOUNTS

From July 1, 1926, to June 30, 1927, the actual disbursements on account of appropriations for the Coast and Geodetic Survey amounted to $2,222,597.80. It must be understood, however, that this does not represent the actual expenses of the survey for the fiscal year 1927, but only the actual disbursements. In a separate report to Congress will be found an itemized statement showing disbursements from each appropriation and subitems thereof, with all detailed information as to character of the expenditure.

These expenditures include the accounts of all chiefs of parties in the field located throughout the United States, Alaska, Hawaii, Porto Rico, the Philippines, and the Virgin Islands. From 30 to 50 chiefs of parties were engaged on field duty at various times during the year, being financed through advances made to them by this division, and accounts arising under such advances were submitted to and through this division to the Treasury Department.

The total appropriations for the fiscal year 1927 were $2,336,670.

INSTRUMENT DIVISION

The survey maintains an instrument division to provide the surveying equipment used by the various field parties and observatories which are engaged in geodetic and hydrographic surveying, precise leveling, terrestrial magnetism and seismology, tides and currents, and the various other bureau activities.

The division's function is to purchase such standard and special makes of instruments and articles of general property as are used and to devise and develop such additional special equipment as is necessary, by virtue of inability to procure these instruments through commercial channels. The division designs, makes detailed drawings, prepares specifications, etc., for such special instruments, repairs and adjusts the active stock, has charge of storage and, in short, performs all the functions necessary for the development, procurement, storage, repair, issuance, and transfer of all the surveying apparatus used by the bureau. These various functions were successfully carried on, the division's work being up to date at the close of the fiscal year, and in addition a number of new instruments and improvements were effected which will provide better and cheaper equipment. The more important of these instruments and improvements are as follows:

First-order theodolite.—This new instrument, which is designed to be fully as accurate as any in existence and to be more rugged and more convenient to operate under the survey's working conditions than any heretofore obtainable, was completed during this year. In it are embodied a number of entirely new features and a few of those of existing instruments which have proven themselves satisfactory to our use. The vertical axis is designed according to a mathematical principle which will eliminate binding due to variations in temperature coefficients of the materials used. The reading microscopes are equipped with glass dials so they may be easily read at night. Microscope adjustments are more positive than those previously used; eccentricity of motion of the alidade due to irregularity of the tangent screw is eliminated, and various other refinements which will make the instrument more accurate and easy to use.

Plane-table alidade.—A new plane-table alidade was designed and a sample procured which will be easier to observe with and more rugged than the previous type. More durable materials are used in its construction and the design is such that various structural weaknesses of the older type are overcome.

Depth indicator.—The device referred to in my report for last year for measuring the depth to which the sounding tube has descended was completed and has successfully passed office tests. This instrument is so arranged that it may be readily placed upon the top of the tube when it is withdrawn from the water and upon pushing a pointed rod down inside the tube until it touches the water contained therein, an electrical circuit is completed through a pair of headphones. The act of pushing this rod downward revolves a scale which reads directly in fathoms by means of a movable pointer. The instrument eliminates the personal equation, prevents loss of water due to

too hasty manipulation, and may be read more closely than the scale used previously.

Radio acoustic apparatus.—It was desired to outfit a ship on the Atlantic coast with a complete set of radio acoustic ranging apparatus. An effort was made to obtain this apparatus through commercial channels, and so high a price was asked and so long a time required for delivery that it was decided to build the equipment in our own plant. The complete apparatus was built in six weeks at a saving of over $10,000, or nearly two-thirds of the amount quoted by the commercial bidder.

Portable automatic tide gauge.—An improvement was made in this instrument in the redesigning of the recording cylinder so that the clock, which formerly served as a bearing for one end of the cylinder as well as the means of rotation, was relieved of all duties as a bearing, now serving as a rotating element only. The weight of the drum, which had caused severe wear and binding, is now supported on a ball bearing. A test of this new cylinder in the field has indicated that this trouble has been entirely eliminated.

Twelve-inch theodolite.—This instrument, which has served the survey well for over 30 years, was designed with an extremely long telescope which was structurally weak and equipped with rather poor optics. The telescope was so long that the instrument could not be used in high latitudes for certain purposes. A new, short, internal-focusing telescope was designed and a sample procured during the year which has the best optics obtainable and which permits observation in any latitude, and furthermore, will facilitate observation, as it is short enough to transmit between the standards.

Tidal reading scales.—A saving was effected by making these scales by photographic means rather than by ruling on glass with a diamond, as has been the practice in the past. An accurate set of negatives has been prepared and duplication is now an easy matter.

Magnetic reading box.—A new type of time-recording apparatus was designed and built for this instrument which eliminates the highly accurate mechanism used in the old style of boxes. Instead of the hour line being recorded by the opening of a mechanical shutter permitting light from a continuously burning lamp to fall upon the sensitized record paper, the device is now so arranged that no shutter is required and the light glows only momentarily each hour for a sufficient length of time to make the necessary exposure. This is effected by a commutator on the driving clock and a thermoelectric switch which opens as soon as the required length of time has elapsed for proper exposure. The length of exposure is easily adjusted.

Current meters.—The recording current meters used by this bureau were improved by the elimination of a number of weaknesses in the original design such as the strengthening of the clock, the improvement of the dials to make the record more easily readable, strengthening of the current vane and its bearings, and several other points of minor importance which will make the instrument more dependable and less liable to damage in the hard field service to which it is subject.

Geodetic level rod.—Five new pairs of rods were completed, the graduations being applied by the new graduating machine which was completed during the past year. The resulting graduations are sharp and clear and pleasing in appearance. The work is performed more quickly than by the hand method and more accurately. A change was made in the design of the rod, which places the accurately graduated strip below the surface so that there should not be as much wear and damage in handling as heretofore.

Experiments were conducted during the year with new methods and materials. Among the more important are the obtaining of several sets of sextant mirrors of stainless steel and the plating of various articles subject to corrosion and wear with the hard metal chromium. Field tests of the steel mirrors indicate that while their reflecting power is not as high as that of perfectly silvered glass, yet it is much better than that of a silvered mirror which has been somewhat damaged by sea water. As the silvering is very easily affected by moisture and the sextants are used principally in open boats, it is believed the metal mirrors will be much more satisfactory in the long run. Further experiments are being conducted with the use of stellite for this purpose, which will be harder and have a higher reflecting power than stainless steel. Chromium plating was used to protect the fine terminal lines of the invar base tapes, to protect the wearing surface of sounding registering sheaves, and to prevent corrosion of the guide rollers of this same apparatus and certain parts of the sounding machine.

A temperature test chamber was built during the year for the purpose of subjecting instruments to all the temperature conditions which they will encounter in the service, either tropical warmth or arctic cold. With this apparatus we will be able to obtain better rating of timepieces, test oils for congelation at low temperatures, and to prevent troublesome binding or loosening of fine bearings due to temperature variations.

NEW CHARTS

No. 1236. Approaches to Cape Fear River, North Carolina, July, 1926. Scale, 1:80,000; dimensions, 31 by 44 inches. Price, 75 cents. This is one of the new series of 1:80,000-scale coast charts and supersedes chart No. 150 of the old series, which is canceled. The chart is based on surveys made from 1923 to 1925 and surveys by the United States Engineers in 1926. It is constructed on the Mercator projection and the soundings are expressed in feet referred to the mean low-water plane.

No. 4608. Sarangani Bay to Mayo Bay, south coast of Mindanao, Philippine Islands. April, 1926. Scale, 1:200,000. Plan of Palmas Island, scale, 1:20,000; dimensions, 33 by 41 inches. Price, 75 cents. This chart shows the results of surveys to 1924 in Sarangani Bay and Strait and in Davao Gulf, and facilitates navigation and the plotting of courses between ports in this region. The plan of Palmas Island shows the results of surveys in 1915.

No. 8254. Snipe Bay to Crawfish Inlet, Baranof Island, southeast Alaska. November, 1926. Scale, 1:40,000; dimensions, 31 by 42 inches. Price, 75 cents. This chart covers a portion of the west coast of Baranof Island and extends from Snipe Bay on the south to Crawfish Inlet on the north. It shows the results of surveys by the United States Coast and Geodetic Survey made in 1924 and 1925. The soundings are in fathoms and refer to the plane of mean lower low water.

No. 8085. Nichols Passage and Seal Cove, southeast Alaska. March, 1927. Scale, 1:5,000; dimensions, 17 by 22 inches. Soundings in feet at mean lower low water. Price, 25 cents. Chart No. 8084 having been canceled, the plan of Seal Cove is now published as chart No. 8085. The area covered by the plan Head of Kasaan Bay is included in new chart No. 8142.

No. 8142. Clarence Strait and Kasaan Bay, southeast Alaska. March, 1927. Scale, 1:40,000; dimensions, 31 by 44 inches. Price, 75 cents. The new chart covers Kasaan Bay and its estuaries, Skowl Arm and Twelvemile Arm. Kasaan Bay, Twelvemile Arm, and Skowl Arm up to Saltery Cove are from surveys made in 1924, while the rest of the chart is from older surveys and miscellaneous authorities. The soundings are in fathoms and give the depths at mean lower low water. The areas that were swept with the wire drag are shown by a tinted overprint. Chart No. 8077 and the plan Head of Kasaan Bay on chart No. 8084 are canceled as the areas are covered by this chart. The remaining plan on chart No. 8084, Seal Cove, is published as a new chart No. 8085.

No. 573. Ossabaw Sound and St. Catherines Sound, Ga. March, 1927. Scale, 1:40,000; dimensions, 31 by 41 inches. Price, 75 cents. This chart replaces charts Nos. 441 and 443 and shows the results of surveys made by the Coast and Geodetic Survey of St. Catherines Sound up to Midway Spit, of Ossabaw Sound up to Middle Marsh in the Ogeechee River and the waters between the shore line and the 20-foot curve, made in 1924 and 1925. The remainder of the chart is from older surveys by the Coast and Geodetic Survey and surveys by the United States Engineers.

No. 8263. Port Walter, Chatham Strait, southeast Alaska. March, 1927. Scale 1:20,000; dimensions, 14 by 19 inches. Price, 25 cents. This chart shows the results of surveys made by the United States Coast and Geodetic Survey in 1925. The area swept with the wire drag is shown by a green tint.

No. 1244. St. Augustine Light to Mosquito Inlet Light, Fla. April, 1927. Scale, 1:80,000; dimensions, 32 by 45 inches. Price, 75 cents. This is one of the new series of coast charts constructed on the Mercator projection on a scale of 1:80,000, in middle latitude. The depths are in feet at mean low water. This chart cancels chart No. 159.

No. 4131. Makapuu Point to Diamond Head, south coast of Oahu, Hawaiian Islands. April, 1927. Scale, 1:20,000; dimensions, 34 by 42 inches. Price, 75 cents. This is the easternmost and first to be published of a series of three charts on a scale of 1:20,000 covering the south coast of Oahu. The soundings are in fathoms at mean lower low water. No details between the shoreline and the general breaker line are charted.

No. 4133. Ahua Point to Barbers Point, south coast of Oahu, Hawaiian Islands. April, 1927. Scale, 1:20,000; dimensions, 34 by 42 inches. Price, 75 cents. This is the second to be published of a series of three charts on a scale of 1:20,000; covering the south coast of Oahu. The soundings are in fathoms at mean lower low water. No depths inside the general breaker line are charted.

No. 4132. Diamond Head to Keahi Point, south coast of Oahu, Hawaiian Islands. April, 1927. Scale, 1:20,000; dimensions, 34 by 42 inches. Price, 75 cents. Charts Nos. 4131, 4132, and 4133 cover the south coast of Oahu. The soundings are in fathoms at mean lower low water. Except at the entrance to Honolulu Harbor, no soundings are charted between the shoreline and the general breaker line.

No. 8261. Ports Alexander, Conclusion, and Armstrong, Chatham Strait, southeast Alaska. May, 1927. Scale, 1:10,000; dimensions, 30 by 40 inches. Price, 75 cents. Soundings in fathoms at mean lower low water. This chart covers a portion of the east coast of Baranof Island, extending from Breakfast Rock on the south to Miner Cove on the north. The surveys were made in 1924 and 1925 with some of the deeper soundings in Chatham Strait from older surveys. This chart cancels the plan of Port Alexander on chart No. 8250.

No. 574. Sapelo and Doboy Sounds, Ga. May, 1927. Scale, 1:40,000; dimensions, 32 by 40 inches. Price, 75 cents. Soundings in feet at mean low water. This chart supersedes chart No. 444, and together with new chart No. 575 it also supersedes chart No. 446. In general, the area between the 30-foot curve and the shore up Sapelo Sound to Dog Hammock and up Doboy Sound to the Duplin River, is from surveys by the United States Coast and Geodetic

Survey made in 1924 and 1925. The remainder of the chart is from earlier surveys by that organization supplemented by surveys of the United States Engineers.

No. 575. Altamaha Sound, Georgia. May, 1927. Scale, 1:40,000; dimensions, 19 by 32 inches. Price, 25 cents. Soundings in feet at mean low water. This chart together with new chart No. 574 supersedes chart No. 446. The soundings from just outside the 18-foot curve to the shore and up Altamaha Sound to Little Mud River on the north and Buttermilk Sound on the south are from surveys by the United States Coast and Geodetic Survey made in 1924 and 1925. The depths in the Inland Waterway are from surveys by the United States Engineers in 1926, and the soundings in the remaining area are from older surveys.

No. 1242. Doboy Sound to Fernandina, Georgia and Florida. June, 1927. Scale, 1:80,000; dimensions, 32 by 41 inches. Price 75 cents. This is one of the new series of coast charts on a scale of 1:80,000, constructed on Mercator projection. It supersedes chart No. 157 of the old series. The depths are charted in feet at mean low water.

Very truly yours,

E. LESTER JONES, *Director*.

BUREAU OF NAVIGATION

DEPARTMENT OF COMMERCE,
BUREAU OF NAVIGATION,
Washington, July 1, 1927.

Hon. HERBERT HOOVER,
Secretary of Commerce.

DEAR MR. SECRETARY: In response to your request, I furnish the following report upon the work of the bureau during the past fiscal year:

AMERICAN SHIPPING ON JUNE 30, 1927

On June 30, 1927, the merchant marine of the United States, including all kinds of documented vessels, comprised 25,778 vessels of 16,887,501 gross tons, of which 2,447 seagoing vessels of 11,071,918 gross tons were 1,000 tons or over, compared with 26,363 vessels of 17,356,421 gross tons on June 30, 1926. Following is an analysis of the ownership of seagoing tonnage compared with one year ago:

Ownership and date	Steel		Wood		Total	
	Number	*Gross tons*	*Number*	*Gross tons*	*Number*	*Gross tons*
Private ownership (500 tons and over):						
July 1, 1926	1,311	5,899,753	685	832,971	1,996	6,732,724
July 1, 1927	1,316	6,057,612	641	778,743	1,957	6,836,355
U. S. Shipping Board (1,000 gross tons and over):						
July 1, 1926	1,054	5,157,889	2	4,445	1,056	5,162,334
July 1, 1927	879	4,539,706			879	4,539,706

Of this tonnage, 1,305 vessels of 6,291,457 gross tons were engaged in the foreign trade and 1,531 vessels of 5,084,604 gross tons in the coasting trade.

Since June 1, 1921, when our foreign trade reached its greatest volume, 10,699,596 gross tons, there has been a steady decline, until June 1, 1927, it amounted to only 6,320,811 gross tons, a falling off of 4,378,785 gross tons.

The decrease in the foreign trade is due, principally, to the scrapping of Shipping Board vessels and to changes from foreign to coasting trade.

Since June 1, 1921, the coasting trade, exclusive of the trade on the Great Lakes, has increased 2,624,017 gross tons. During the same six years the total seagoing tonnage has decreased 1,945,127 gross tons.

During the year 882 vessels of 245,122 gross tons were built and documented and on July 1, 1927, there were building or under contract to build in our shipyards 280 vessels of 219,044 gross tons.

On June 30, 1927, the laid-up seagoing tonnage of the United States aggregated 751 vessels of 3,033,452 gross tons, as against 1,032 vessels of 3,922,394 gross tons on June 30, 1926, a decrease of 281 vessels and 888,942 gross tons. The figures for 1926 include 58 vessels of 125,917 gross tons which had been sold to be scrapped but had not been delivered at the end of the fiscal year. All of these vessels have now been delivered and are therefore omitted from the 1927 total. An examination of these figures shows that the Shipping Board laid-up tonnage has decreased 210 vessels of 705,854 gross tons and the privately owned tonnage has decreased 71 vessels of 183,088 gross tons. The decrease in Shipping Board laid-up tonnage is due partly to sales to private owners.

Details of the world's laid-up seagoing tonnage, classification of American vessels by size, service, and power, and details of vessels launched and under construction may be found in Merchant Marine Statistics for 1927.

NAVIGATION LAWS

Under section 4 of the act of July 5, 1884 (23 Stat. 119, U. S. C. Title 46, sec. 4), the Commissioner of Navigation is directed to enforce the operation of the laws relative to navigation and annually report to you such particulars as may admit of improvement or may require amendment. The following suggestions therefore are presented:

INSPECTION OF MOTOR SHIPS

Our inspection laws are contained in Title LII of the Revised Statutes and laws amendatory and supplementary thereto. When these laws were passed motor vessels were practically unknown and many of the provisions of such laws in terms apply only to steam and sail vessels, but one section of the statutes (4426 R. S., U. S. C. Title 46, sec. 404) applying to motor vessels specifically.

The use of internal-combustion engines is increasing and such engines are now used on many large seagoing vessels. On June 1 last we had documented under the American flag 74 such vessels of 1,000 tons and over, aggregating over 263,000 tons, in the seagoing trade alone. As a matter of practice these vessels are undergoing full inspection by courtesy of the owners. This practice should be recognized in the law for the protection of the owner, the vessel, her passengers, and crew.

LOAD LINE

Legislation on this subject which failed during the last Congress is important (1) in consideration of the safety of the vessel and crew and the avoidance of the damage and extensive repairs inevitable with inadequate freeboard, and (2) because the leading maritime nations already have load-line provisions and their laws require our ships loading in their ports to comply with their several detailed requirements in the absence of similar regulations of our own.

The United States, with a fleet in the foreign trade (500 tons and over) of 1,305 vessels of over 6,291,000 tons, is now the only maritime nation of importance whose commerce is liable to be hampered by these provisions.

It is hoped that it may be possible for the shipping interests and others concerned to agree on provisions of such legislation to meet the peculiar conditions of our shipping and secure the benefits to our commerce such a law would provide. As a matter of national pride load lines on American vessels should be fixed under American regulation.

PERSONNEL OF MARITIME BUREAUS

Under its organic act the Department of Commerce is charged with the general superintendence of the commercial marine and merchant seamen of the United States so far as vessels and seamen are not under existing laws subject to the supervision of any other officer of the Government.

To this end unusual powers are vested in the department, in many instances its decision being final. Notwithstanding the intricacies and technical nature of the administration of these laws under the present organization, the Department of Commerce must in the main carry out such administration through employees of the Treasury Department selected, appointed, and paid by that department.

In several previous reports the bureau has presented in some detail the many reasons why this condition should not longer continue. The department charged with the administration of the great bulk of the navigation laws should be vested with authority to employ the personnel through which the work for which it is responsible is carried out.

There is accumulating more and more evidences of the disadvantage of the present system as new laws are enacted placing on the Department of Commerce new duties and responsibilities.

The obvious solution of the difficulty is the transfer to the Department of Commerce of the selection, appointment, and remuneration of employees of the Treasury Department now engaged under instructions of the Department of Commerce in carrying out the laws for the administration of which the Secretary of Commerce through the Bureau of Navigation is responsible.

This will necessarily result in more responsive action, engender an interest in the work, and consolidate efforts, all of which will attract competent men and through a central direction render expert and adequate service to shipowners and their crews not now possible under the present unbusinesslike organization.

ENFORCEMENT OF THE NAVIGATION LAWS

During the past year there were reported to the department for mitigation and remission of penalties 8,306 violations of the navigation laws. The following table shows the enforcement of such laws by customs districts and laws violated followed by a comparison with the work of previous years:

Table showing, by ports, the navigation laws violated and the number of violations during the year ended June 30, 1927

	Total	Steamboat laws (R. S. 4399–4500, U. S. C. Title 46, secs. 361–498)	Motor-boat laws (36 Stat. 462, U. S. C. 511–519), "Rules of road" (26 Stat. 320–328, 28 Stat. 645–650, 29 Stat. 690–691, U. S. C. Title 33, secs. 61–351)	Surrendered license (R. S. 4325–4326, U. S. C. Title 46, secs. 267–268)	Seamen's act (38 Stat. 1164, 1169, U. S. C. Title 46, secs. 672–673)	Anchorage and St. Marys River rules (29 Stat. 54, 34 Stat. 136, U. S. C. Title 33, sec. 474)	Passenger act (22 Stat. 186–191, U. S. C. Title 46, secs. 151–162, 171)	Enrollment and license (R. S. 4336, U. S. C. Title 46, sec. 277)	Entry and clearance (R. S. 4197, U. S. C. Title 46, sec. 91)	Name on vessel (R. S. 4178, U. S. C. Title 46, sec. 46)	Change of master (R. S. 4335, U. S. C. Title 46, sec. 276)	Unlading (R. S. 4351, 4355, U. S. C. Title 46, secs. 296, 300)	Numbering act (40 Stat. 602, U. S. C. Title 46, secs. 288–289)	Miscellaneous
Baltimore	361	39	232	12						9			61	8
Boston	833	132	363	80				22	11	16	3	1	186	19
Bridgeport	310	1	179	23				14		13	8		69	3
Buffalo	34	3	1	1									29	
Charleston	110	2	60	24				1		3	1		18	1
Chicago	97	10	53	9	1								24	
Cleveland	84	8	48	6	4	1		3	1				13	
Detroit	184	19	95	19					4				46	1
Duluth	38	9	21		2	1							5	
Galveston	26	1		24									1	
Honolulu	12			3									1	8
Indianapolis	7	2	4										1	
Juneau	51	1	3	24				2	2		2	2	15	
Los Angeles	261	32	114	36	1			6	7	2	2	6	28	27
Louisville	35	1	11	4									19	
Memphis	120		37	28				8		5			42	
Milwaukee	104	3	24	3				2	1	12			51	8
Mobile	263	11	108	22	1			4		8	1		100	8
New Orleans	186	46	51	47				2	8	8		1	18	5
New York	1,185	85	489	311	2			34	8	34	13		189	20
Nogales	14													14
Norfolk	434	53	220	28	1			4	3	26	10		79	10
Ogdensburg	142	1	18	5				1	2				114	1
Philadelphia	303	21	65	83	2			4	2	4	2	1	118	1
Pittsburgh	53	5	3	42				1			2			
Port Arthur	15	4	1	8									1	1
Portland, Me	159	8	74	24				2	4	5			39	3
Portland, Oreg	84	3	29	18				4	3	3	4		12	8
Providence	217	3	170	4						7	3		24	6
Rochester	24	4	12					1					5	2
St. Albans	22		14	2					2				4	
St. Louis	64		37	3									24	
San Antonio	8			1									7	
San Francisco	238	66	36	22	3		1	7	6	2	5		57	33
San Juan	22		7	7				1	3			1		3
Savannah	47		23	14						1	1		8	

Table showing, by ports, the navigation laws violated and the number of violations during the year ended June 30, 1927—Continued

	Total	Steamboat laws (R. S. 4399–4500, U. S. C. Title 46, secs. 361–498)	Motor-boat laws (36 Stat. 462, U. S. C. 511–519), "Rules of road" (26 Stat. 320–328, 28 Stat. 645–650, 29 Stat. 690–691, U. S. C. Title 33, secs. 61–351)	Surrendered license (R. S. 4325–4326, U. S. C. Title 46, secs. 267–268)	Seamen's act (38 Stat. 1164, 1169, U. S. C. Title 46, secs. 672–673)	Anchorage and St. Marys River rules (29 Stat. 54, 34 Stat. 136, U. S. C. Title 33, sec. 474)	Passenger act (22 Stat. 186–191, U. S. C. Title 46, secs. 151–162, 171)	Enrollment and license (R. S. 4336, U. S. C. Title 46, sec. 277)	Entry and clearance (R. S. 4197, U. S. C. Title 46, sec. 91)	Name on vessel (R. S. 4178, U. S. C. Title 46, sec. 46)	Change of master (R. S. 4335, U. S. C. Title 46, sec. 276)	Unlading (R. S. 4351, 4355, U. S. C. Title 46, secs. 296, 300)	Numbering act (40 Stat. 602, U. S. C. Title 46, secs. 288–289)	Miscellaneous
Seattle	328	37	133	45	2	----------	1	6	19	13	3	10	44	15
Tampa	1,519	22	351	121	1	----------	----------	148	377	16	12	--------	453	18
Wilmington	312	22	158	27	1	----------	----------	6	1	10	5	--------	78	4
Total—														
1927 (39 ports)	8,306	654	3,244	1,130	21	2	2	283	464	197	77	22	1,983	227
1926 (39 ports)	10,778	2,501	3,722	1,330	47	3	9	178	272	285	83	18	2,080	248
1925 (40 ports)	9,544	922	3,487	1,446	34	4	5	453	238	224	92	16	2,374	249
1924 (40 ports)	8,867	547	2,782	1,069	104	55	18	185	116	445	78	16	3,201	250
1923 (40 ports)	11,251	695	3,069	945	405	11	10	1,130	79	505	49	17	4,117	215
1922 (41 ports)	11,412	422	4,614	944	75	----------	27	59	71	443	56	110	4,426	158
1921 (42 ports)	10,707	840	3,772	974	250	----------	48	45	100	673	68	42	3,676	208
1920 (41 ports)	10,667	2,650	2,530	988	514	----------	16	38	104	267	39	118	3,192	160
1919 (40 ports)	8,173	1,589	2,397	1,066	273	----------	28	38	83	196	32	83	2,244	86
1918 (49 ports)	4,749	710	2,337	922	160	----------	32	20	62	127	27	250	----------	82
1917 (48 ports)	7,569	1,020	4,660	770	286	----------	29	42	43	400	41	74	----------	182
1916 (48 ports)	7,825	812	5,126	943	271	1	19	59	28	331	35	67	----------	90
1915 (48 ports)	6,868	671	4,462	982	----------	11	10	104	41	348	67	93	----------	42
1914 (49 ports)	6,720	768	4,838	631	----------	8	25	41	26	153	59	90	----------	45
1913 (107 ports)	3,506	333	2,783	23	----------	23	8	24	10	83	26	1	----------	152
1912 (105 ports)	3,634	165	3,119	96	----------	12	17	38	39	81	12	--------	----------	55
1911 (92 ports)	2,268	182	1,811	23	----------	17	45	10	16	43	30	--------	----------	91
1910 (74 ports)	1,070	252	488	17	----------	13	61	13	16	68	12	2	----------	128
1909 (64 ports)	1,134	151	710	33	----------	3	21	14	7	59	----------	4	----------	132
1908 (73 ports)	852	245	385	12	----------	6	21	23	18	30	7	2	----------	103
1907 (66 ports)	684	209	92	88	----------	18	62	9	23	52	27	5	----------	99
1906 (77 ports)	670	194	130	114	----------	13	27	10	6	49	5	9	----------	113
1905 (63 ports)	524	142	53	99	----------	13	21	26	7	20	11	28	----------	104
1904 (66 ports)	706	184	93	101	----------	49	16	29	12	24	19	(1)	----------	179

[1] Included under "Miscellaneous" in 1904 report.

The foregoing table is based on reports of collectors of customs and is approximately correct. The decrease in the number of violations considered for 1927 is caused by new methods of handling technical deficiencies in equipment which are not of a nature to warrant formal charges being filed and the entry of the cases on the department's books. The purposes of the law are remedial and not punitive and the bureau is satisfied that the affidavit of the owner of the boat, that since the inspection he has remedied the deficiency in equipment, is effective in the more technical violation.

In such cases, however, a careful check is maintained and should the vessel again be reported formal action is taken.

It will also be noted that there is a material falling off in the number of violations of the steamboat-inspection laws. This is due to the partial suspension of reports of violations of the law prohibiting the starting of engines of automobiles while on ferryboats until such boats are fast in their slips. At one port alone over 1,000 cases were reported in a single month last year. Through notices posted on ferryboats, warnings by the officers of such vessels, and signals being given when the time for starting the engines has arrived, it is hoped that in the near future there will be a general compliance with the statute without causing unnecessary annoyance and the imposition of penalties.

The following table shows the work done by the various branches of the service engaged in the enforcement of the navigation laws in comparison with previous years:

Headquarters port	Total	Kilkenny	Tarragon	Dixie	Siwash	Psyche	Coast Guard	Local inspectors	Customs	Navigation inspectors
Baltimore	361	269				1	38	38	15	
Boston	833				371		120	34	272	36
Bridgeport	310				253		13	3	41	
Buffalo	34							3	31	
Charleston	110		38				44		28	
Chicago	97						74	10	13	
Cleveland	84						10	10	28	36
Detroit	184						94	22	68	
Duluth	38						3		14	21
Galveston	26								26	
Honolulu	12								12	
Indianapolis	7							2		5
Juneau	51						5		46	
Los Angeles	261						32	33	101	95
Louisville	35	20						1	4	10
Memphis	120	68							49	3
Milwaukee	104						94	3	7	
Mobile	263	161		62			3	10	27	
New Orleans	186			6			8	54	118	
New York	1,185	4			419	194	108	57	403	
Nogales	14								14	
Norfolk	434	148				3	216	28	39	
Ogdensburg	142					12		1	129	
Philadelphia	303	44				24	25	20	190	
Pittsburgh	53							6	47	
Port Arthur	15								15	
Portland, Me	159						71	3	85	
Portland, Oreg	84						3	12	69	
Providence	217				133		12	5	6	61
Rochester	24					9	3	3	9	
St. Albans	22					12			10	
St. Louis	64								64	
San Antonio	8								8	
San Francisco	238						49	42	114	33
San Juan	22						4		18	
Savannah	47		30			1	2		14	

Headquarters port	Total	Kilkenny	Tarragon	Dixie	Siwash	Psyche	Coast Guard	Local inspectors	Customs	Navigation inspectors
Seattle	328						145	4	127	52
Tampa	1,519	4	284	1			269	19	942	
Wilmington	312	25	16			144	103		24	
Total—										
1927 (39 ports)	8,306	743	368	69	1,176	400	1,548	423	3,227	352
1926 (39 ports)	10,778	987	387	315	941	1,909	1,504	245	3,548	941
1925 (40 ports)	9,544	472	401	515	970	874	1,179	222	4,040	871
1924 (40 ports)	8,867	1,192	787	1,078	671	586	616	327	3,312	297
1923 (40 ports)	11,251	1,332	829	1,111	1,060	1,172	521	799	3,883	540
1922 (41 ports)	11,396	1,184	999	764	1,275	2,500	509	317	3,203	630
1921 (42 ports)	10,706	1,637	1,112	1,182	712	479	404	773	3,869	529
1920 (42 ports)	10,667	1,303	1,261	41			300	2,083	5,028	626
1919 (41 ports)	7,382	1,480	1,226				235	767	3,114	554
1918 (49 ports)	4,893	84	809				241	404	2,654	696
1917 (48 ports)	7,565		1,234	864			1,255	712	2,833	654
1916 (48 ports)	7,895		987	984			1,333	590	2,876	1,089
1915 (48 ports)	6,860		1,425				1,380	361	2,661	999

Of the above 8,306 violations, 2,756 were reported by the bureau's 5 patrol boats. The number of inspections made this year by these vessels was 22,522, which indicates that only 1 vessel in 10 was found without the required equipment. The bureau is satisfied that vessels in the waters covered by this patrol are reasonably well equipped as a result, in part, of the work of these vessels, but principally because of cooperation of the vessel owners themselves and motor-boat organizations.

Following is a comparative statement of cases of violations of the navigation laws reported by officers of customs, 1915–1927:

Comparative statement of cases of violations of the navigation and steamboat-inspection laws reported by officers of customs, 1915–1927

Port	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927
Baltimore	396	312	461	265	500	663	699	482	480	419	161	300	361
Boston	440	412	427	194	243	626	607	898	711	566	767	800	833
Bridgeport	118	54	89	32	95	97	200	50	287	131	206	131	310
Buffalo	42	144	87	111	168	143	188	62	116	262	90	24	34
Charleston	91	39	50	28	109	40	44	68	192	136	105	82	110
Chicago	178	389	283	144	88	119	171	97	179	165	139	76	97
Cleveland	104	218	161	177	499	1,096	252	160	154	303	187	97	84
Des Moines	85	4	116	56	27	40	141	32	62	48	11		
Detroit	293	441	163	146	142	122	168	67	184	311	80	83	184
Duluth	62	79	138	132	282	241	73	68	245	79	44	42	38
Eagle Pass			1	1									
Galveston	49	50	105	54	21	24	41	8	10	167	78	57	26
Great Falls										3			
Honolulu	14	18	18	11	10	3	95	35	22	16	45	10	12
Indianapolis	5	109	54	85	32	34	29	37	3	2	4		7
Juneau	43	33	40	44	43	39	60	36	77	130	106	78	51
Laredo	2	7	10										
Los Angeles	182	172	137	109	192	125	183	185	178	131	127	171	261
Louisville	58	63	128	50	49	64	35	57	29	26	28	54	35
Memphis	52	94	84	18	67	83	66	86	62	162	150	154	120
Milwaukee	8	133	82	18	81	133	33	14	79	17	5	7	104
Mobile	107	106	109	52	98	122	301	203	334	234	191	96	263
New Orleans	173	177	315	221	501	487	779	294	467	790	371	411	186
New York	622	1,256	1,292	583	626	1,349	849	2,698	1,475	663	1,625	2,454	1,185
Nogales				22		8	21	13		7	12	10	14
Norfolk	335	531	430	181	814	618	846	680	682	412	375	842	434
Ogdensburg	40	92	74	201	54	18	8	85	85	18	112	58	142
Omaha							1						
Pembina				3									
Philadelphia	867	483	406	166	532	600	684	778	624	360	854	549	303
Pittsburgh	13	27	4	6	9	28	16	22	14	41	35	16	53
Port Arthur	33	68	93	117	203	256	112	21	17	216	84	52	15
Portland, Me	566	241	145	51	53	55	320	346	440	295	393	684	159

Comparative statement of cases of violations of the navigation and steamboat-inspection laws reported by officers of customs, 1915–1927—Continued

Port	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927
Portland, Oreg.	273	229	130	239	120	182	107	83	101	171	291	237	84
Providence	21	125	94	68	65	137	175	181	98	94	144	169	217
Rochester	28	42	44	102	14	24	55	10	61	57	53	18	24
St. Albans	3	33	68	29	1	1	3	96	2	-----	4	4	22
St. Louis	186	154	348	173	291	396	182	173	179	127	89	100	64
St. Paul	1	5	-----	-----	4	-----	-----	-----	-----	-----	-----	1	-----
San Antonio [1]	-----	-----	-----	2	2	7	9	10	25	23	28	15	8
San Diego [2]	-----	-----	-----	-----	-----	1	22	34	32	-----	-----	-----	-----
San Francisco	446	276	196	151	223	765	466	213	291	288	284	281	238
San Juan	28	11	12	14	8	14	10	14	19	18	26	25	22
Savannah	78	82	48	41	77	68	149	165	163	126	126	67	47
Seattle	306	409	318	338	266	320	310	272	1,223	294	564	755	328
Tampa	314	570	547	295	1,303	1,247	1,770	2,300	1,649	1,386	1,398	1,690	1,519
Wilmington, N. C.	206	137	262	19	261	302	426	263	200	173	152	78	312
Total (47 ports)	6,868	7,825	7,569	4,749	8,173	10,667	10,706	11,396	11,251	8,867	9,544	10,778	8,306

[1] The districts of Laredo (No. 23) and Eagle Pass (No. 25) were abolished by Executive order Sept. 7, 1917, and the district of San Antonio (No. 23) was created by the same order.
[2] The districts of Los Angeles and San Diego were consolidated by Executive order of Jan. 26, 1923, with Los Angeles as headquarters port.

The above is an accurate indication of the volume of this work performed by customs officers under the direction of the Secretary of Commerce. It does not necessarily indicate the activity of the customs offices in their districts, as such districts operating the Atlantic and Gulf coasts have the assistance of the inspection vessels of this department.

The enforcement of the act of June 7, 1918, requiring that the name and address of the owners of small undocumented vessels shall be recorded in the customhouses is proceeding satisfactorily. Under this law there were on June 30, 1927, 214,099 vessels so recorded, an increase of 10,389 over the previous year. The records indicate for some years past an increase of about 10,000 vessels per year numbered under this law.

PREVENTING OVERCROWDING OF PASSENGER VESSELS

The importance of preventing the overcrowding of passenger vessels necessitates a careful organization of this service, which is performed by customs, navigation, and steamboat-inspection officers. The local inspectors of steam vessels, under the regulations of the service, prescribe the number of passengers which a vessel may carry with safety. It is the business of the navigation inspectors of this bureau at the ports served by them to supervise the taking on of passengers and prevent any overloading. The experience of the service has been that the masters of passenger vessels with few exceptions endeavor to comply with the law and safeguard the vessel and her passengers.

The following table shows the counts and number of passengers involved in preventing the overcrowding during the fiscal year 1927:

Number of counts and the number of passengers involved in preventing overcrowding of passenger vessels during fiscal year 1927

Port	Navigation		Customs		Total	
	Counts	Passengers	Counts	Passengers	Counts	Passengers
Baltimore	1,972	628,628			1,972	628,628
Boston			364	267,008	364	267,008
Chicago	1,775	494,127	68	48,498	1,843	542,625
Cleveland	867	499,067	133	113,008	1,000	612,075
Detroit	616	1,101,693	3	2,161	619	1,103,854
Duluth				22,699		22,699
Galveston			104	7,542	104	7,542
Louisville	390	223,751			390	223,751
Memphis	66	22,284			66	22,284
New York				1,803,690		1,803,690
Norfolk	576	105,108	23	6,898	599	112,006
Philadelphia			257	187,246	257	187,246
Portland, Me	425	53,382	38	7,198	463	60,580
Rochester			40	4,540	40	4,540
Seattle	346	47,249	478	28,416	824	75,665
Total	7,033	3,175,289	1,508	2,498,904	8,541	5,674,193
Total, 1926	8,287	3,454,436	1,400	3,142,330	9,687	6,596,766

When, in the course of counting passengers it is found that the limit of safety has been reached, as shown by the number permitted by the certificate of inspection, the navigation inspectors stop passengers going on board. The number of such shut-offs is shown by the following table:

Shut-offs, by specified months

Port	July, 1926		August, 1926		September, 1926		May, 1927		June, 1927		Total	
	Counts	Passengers	Counts	Passengers	Counts	Passengers	Counts	Passengers	Counts	Passengers	Counts	Passengers
Baltimore	9	8,000	3	2,800	1	1,300					13	12,100
Boston	1	1,650	2	3,300							3	4,950
Chicago	65	30,729			18	9,460			13	5,329	96	45,518
Cleveland			4	8,536							4	8,536
Detroit	12	37,316	2	5,071	1	3,008	1	3,008	7	19,687	23	68,090
Louisville									2	1,600	2	1,600
New York										4,155		4,155
Norfolk	3	1,536	3	1,845			1	350			7	3,731
Philadelphia	1	500	1	500							2	1,000
Portland, Me	1	92									1	92
Seattle			1	25							1	25
Total	92	79,823	16	22,077	20	13,768	2	3,358	22	30,771	152	149,797
Total, 1926	198	171,485	85	63,219	20	6,949	3	608	31	46,676	337	288,937

It will be noted that on 152 occasions the limit of safety had been reached and it was necessary for our inspectors to take action. This involved 149,797 passengers. The bureau is satisfied that in the absence of our inspection service there would have been overcrowding in each of these cases.

SHIPPING COMMISSIONERS

During the year 561,054 officers and men were shipped, reshipped, and discharged before shipping commissioners, as compared with 534,493 for the year before. The average cost for the service was 22 cents per man as against 23 cents the previous year. Collectors of customs acting at ports where shipping commissioners' offices have not been established, shipped and discharged during the year 64,027 officers and men as compared with 53,789 officers and men during the previous year.

Of the 285,269 officers and men shipped before shipping commissioners, 134,531 were native Americans, 40,947 naturalized Americans; 175,478 in all, or 61 per cent. This does not give an entirely accurate idea of the nationality of crews on our vessels, as under the law vessels may sign on a portion of alien crews before United States consuls for the round trip.

The following table shows the aggregate routine work and salaries of the shipping commissioner service for the past decade:

Year	Seamen shipped, reshipped, and discharged	Salaries	Average cost per man	Year	Seamen shipped, reshipped, and discharged	Salaries	Average cost per man
1917	506,941	$66,211	$0.13	1923	538,755	$94,476	$0.17
1918	457,248	72,075	.16	1924	555,633	94,476	.17
1919	485,796	75,288	.15	1925	552,124	123,726	.22
1920	628,980	85,949	.13	1926	534,493	123,183	.23
1921	650,840	99,646	.15	1927	561,061	122,398	.22
1922	541,952	92,318	.17				

The above table, however, does not cover the most important branch of the service—the arbitration of disputes between masters and members of the crew.

During the year approximately 11,000 cases were decided by the shipping commissioners involving questions on almost all phases connected with their general supervisory authority over the contracts of employment and welfare of seamen.

This service is the agency through which the laws governing the employment of seamen are administered. It originated under the act of June 7, 1872, the commissioners being appointed by and acting as officers of the circuit courts. Under subsequent laws their appointment was entrusted to the Secretary of Commerce, heavy bonds being required for the faithful performance of their duties, which remain unimpaired.

The general duties of the service are to afford facilities for engaging seamen, supervise their engagement and discharge, provide means for securing their presence on board, facilitate the making of apprenticeships, and of special importance the shipping commissioner shall hear and decide any question whatever between the employer and the members of the crew which both parties agree in writing to submit to him. Every award made by the shipping commissioner after such hearings is binding on both parties and conclusive as to their rights (sec. 4554, R. S.).

The judicial power thus placed in the shipping commissioner has proved beneficient. It affords seamen and their employers a full

hearing upon any question and judgment in accordance with the facts and the law without expense or delay. The commissioner may require the production of log books, and all other documents bearing on the question at issue shall be presented.

As stated in the Pennsylvania Law Review of January, 1913, "The entire subject of the jurisdiction and summary powers of United States Shipping Commissioners is one which furnishes a most interesting study in administrative process, and supplies in practice perhaps the most conspicuous justification of summary process to be found in our entire Federal system."

Because of the peculiar nature of the employment of seamen in the foreign trade, far distant from their home ports and without the immediate protection of our courts, Congress through numerous statutes has safeguarded their interests perhaps more closely than any other class of employees. That the benefits of these laws may be enjoyed by the seamen there must be impartial and intelligent judgment by men thoroughly grounded in the law and the customs of the sea.

ESTABLISHMENT OF NEW SHIPPING COMMISSIONERS' OFFICES

Under the law where Congress has not provided for the employment of shipping commissioners, the work is performed by collectors of customs acting as such. This provision is intended to apply where the number of men shipped and discharged is small and as a matter of economy.

It has been the practice for many years that when the shipment of men during several consecutive years has averaged 1,000 men each year, to recommend to Congress the establishment of an independent office in order that the seamen may have the benefit of trained men engaged exclusively in the supervision of their contracts and their protection afloat and ashore. For some years there has been a steady increase in the work at the ports of Mobile and San Pedro (Los Angeles), the average per year for the last three years being 5,057 men at Mobile and 11,630 men at San Pedro. Chambers of commerce, shipping interests, and the customs officers are strongly urging the establishment of these new offices.

ALLOTMENT NOTES

Existing law prohibits the payment in American or foreign ports of wages to seamen in advance to earning such wages. However, in order to provide for their dependents, provision is made for the issue of allotment notes payable from the seamen's wages as earned to grandparents, parents, wives, sisters, or children. Any other order, note, or evidence of indebtedness from such wages is void. The issue of these notes is supervised by the United States Shipping Commissioner and signed by him.

The total number of allotment notes thus issued by shipping commissioners was 6,703, as compared with 5,978 during the previous year and 6,475 during 1925.

PASSENGER ACT OF 1882

The following table shows the number of voyages and the steerage passengers involved during the past six years:

Year	Voyages	Steerage passengers	Year	Voyages	Steerage passengers
1922	1,057	250,741	1925	1,257	187,127
1923	1,256	323,006	1926	1,334	215,639
1924	1,235	348,989	1927	1,367	275,175

The administration of the passenger act of 1882 (22 Stat. 186–191, U. S. C. Title 46, secs. 151–162, 171) is closely supervised as it is important to the health, morals, and comfort of approximately 270,000 future citizens of the United States entering our ports on vessels from abroad. This act has to do with proper ventilation for the spaces such passengers occupy, proper food, sanitary conditions maintained throughout the voyage, sexes kept separate, and hospital and medical facilities kept available at all times.

NAVIGATION RECEIPTS

The receipts from tonnage during the fiscal year amounted to $2,245,511.68, as compared with $1,825,719.39 the year before. There is a similar proportionate increase in navigation fees collected and in the total collections, which aggregate $2,590,231.91. These receipts in detail were as follows:

June 30—	Tonnage duties	Navigation fees	Navigation fines	Total
1927	$2,245,511.68	$240,986.02	$103,734.21	$2,590,231.91
1926	1,825,719.39	227,079.09	127,872.98	2,180,671.46
1917	1,393,743.16	159,808.03	49,962.37	1,603,513.56

The accounts for these various collections are rendered by collectors of customs and checked in the Bureau of Navigation against their deposits in the United States Treasury.

PUBLICATIONS

Publications of the bureau comprise the Navigation Laws (quadrennial with annual pamphlet supplement), Merchant Vessels of the United States (annual), Code List of Merchant Vessels (annual), and American Documented Seagoing Vessels of 500 gross tons and over (monthly).

The publications are no longer issued gratuitously, but are for sale by the Superintendent of Documents, Government Printing Office, Washington, D. C.

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.

Very truly yours,

A. J. Tyrer,
Commissioner of Navigation.

STEAMBOAT INSPECTION SERVICE

DEPARTMENT OF COMMERCE,
STEAMBOAT INSPECTION SERVICE,
Washington, July 1, 1927.

HON. HERBERT HOOVER,
Secretary of Commerce.

DEAR MR. SECRETARY: Herewith is submitted the report of the Steamboat Inspection Service for the fiscal year ended June 30, 1927.

REORGANIZATION

The Steamboat Inspection Service is one of the oldest bureaus in the Federal Government. Its organization reflects the thought and ideals of the country a hundred years ago. Though the framers of the laws governing the Steamboat Inspection Service in many instances builded better than they knew, it is time to make certain changes to meet existing conditions. I suggest the following:

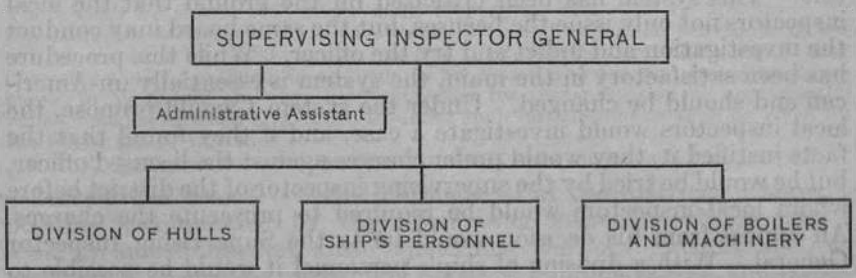
Change of name.—The name "Steamboat Inspection Service" does not properly describe the functions and activities of the organization. Although one of its functions is to inspect steam vessels, it also has to inspect motor vessels, motor ships, sailing vessels of certain classes, and seagoing barges. It is suggested that the name "Marine Inspection Service" would be more appropriate and could be very properly adopted.

The head of the service is known as the Supervising Inspector General. A more correct official title would be director. The assistant should be known as assistant director. This would be more in conformity with marine practice and with the intention of the law that relates to the appointment of a Supervising Inspector General, whose business is to see that the laws are carried into effect, and who is selected for his ability to enforce these laws. The requirements for the Supervising Inspector General are entirely different from those of the supervising, local, or assistant inspectors. Inasmuch as his functions are entirely of a directory nature, the title "director" would be more in conformity with the law and the actual practice of the office.

Acentral staff.—The Supervising Inspector General is, under the law, directed to obtain uniformity, but the machinery with which he works has, in many instances, to function before he can know whether there is any lack of uniformity. The right time to obtain uniformity is before the action is taken. This can be done by the creation in the central office of a technical staff. The service has often stressed its dependency upon "practical" men, and its regulations require that

only men who have been officers on ships can hold positions as inspectors. This has obtained good results thus far, but it is desirable to obtain even better results in the future. To do this it is my desire, while availing myself of all that the practical men know, to create and develop a technical staff. The day for rule-of-thumb methods is past and the day of the technician is at hand. It is not sufficient for the Board of Supervising Inspectors to legislate as necessity arises, but it should have at its command the machinery with which to plan in advance. That can only be done by a central staff of technical men, the result of whose investigation from the technical side would be available to the Board of Supervising Inspectors working from the practical and legislative side.

There is submitted below a chart of organization which the bureau desires to see adopted:



The division of hulls would be under a trained naval architect, who should have about four inspectors and three or four clerks to assist him. He would have charge of the stability work, and look after it in such a manner as to be able to advise the shipbuilding companies which may seek information. The division of hulls could also do valuable work in regard to bulkhead construction.

The division of boilers and machinery would be in charge of a chief with about four inspectors and two or three clerks. He would look after the inspection of all boilers designed for vessels of the American merchant marine. At the present time boilers are approved by 46 different boards of local inspectors. In the interest of uniformity there should be a directing head over this work with authority over its technical phases. While uniformity would be obtained, safety would be the paramount thought. A division of this character could work out methods for the inspection of boilers much better than the boards of local inspectors. In the approval of designs it would have in mind at all times easy accessibility of inspection, because, while a boiler may be built of good material that meets in all respects the requirements or provisions of the statutes, its design may make it impossible to inspect it thoroughly to ascertain its actual condition.

The division of ship's personnel would be under a chief with about five inspectors and four clerks to assist him. In licensing officers and certificating able seamen many problems arise that are not apparent to one who is not familiar with marine work. They come up n t only in issuing licenses and certificates, but in the discipline that the service exercises over ships' personnel. To exercise this discipline effectively the service must at all times be just, beginning with the

time when an applicant applies for his license or certificate. While in the issuance of licenses and certificates boards of local inspectors have the statutes and regulations to guide them, it is easy to see that with 46 issuing offices throughout the service there can be lack of uniformity. A division of ships' personnel would bring about uniformity. It would prepare standard sets of examination questions for the guidance of the inspectors, these to be supplemented by questions to meet local conditions. With such procedure it would be impossible to claim that it was easy to get a license at one port and difficult at another.

After a license or certificate has been issued, this service watches over the conduct of the officer in his everyday life, and if it is such as to warrant the action, his license can be suspended or revoked. To-day ships' officers are indicted and tried by boards of local inspectors. This system has been criticized on the ground that the local inspectors not only issue the licenses, but the same board may conduct the investigation and indict and try the officer. While this procedure has been satisfactory in the main, the system is essentially un-American and should be changed. Under the system I would propose, the local inspectors would investigate a case, and if they found that the facts justified it, they would prefer charges against the licensed officer, but he would be tried by the supervising inspector of the district before whom local inspectors would be required to prosecute the charges. An appeal from his decision would lie to the Supervising Inspector General. With a division of ship's personnel it would be possible to require that reports of investigations of casualties, violations of law, etc., in detail, with transcripts of testimony, be sent to the central office for review, in the course of which any errors in procedure could be corrected.

PERSONNEL

The following positions were embraced in the Steamboat Inspection Service at the close of business on June 30, 1927:

At Washington, D. C.:	
Supervising Inspector General	1
Deputy Supervising Inspector General (who is acting Supervising Inspector General in the absence of that officer)	1
Traveling inspectors	3
Clerks	10
Messenger	1
In the service at large:	
Supervising inspectors	10
Local inspectors of hulls	46
Local inspectors of boilers	46
Assistant inspectors of hulls	75
Assistant inspectors of boilers	75
Clerks	92
Total	360

It was my duty during the year to recommend the appointment of two new men as supervising inspectors, one at New York, N. Y., and the other at Pittsburgh, Pa. In filling these positions, the bureau received many indorsements of men outside of the service. However, the positions were filled by the promotion of men in the service, who had earned the promotion by long years of faithful and efficient work.

While the pressure brought to bear did not result in the appointment of persons who had had no training, it did emphasize again the necessity of having this class of employees under the classified civil service.

A bill to amend section 4404, Revised Statutes (U. S. C., Title 46, sec. 373), as amended by the act approved July 2, 1918, placing the supervising inspectors under the classified civil service, is, therefore, quoted below, with the recommendation that everything possible be done to have it enacted into law:

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That section 4404 of the Revised Statutes of the United States, as amended by the act of Congress approved July 2, 1918, be, and the same is hereby, amended so as to read as follows:

"SEC. 4404. The positions of supervising inspector in the Steamboat Inspection Service are hereby placed under and included in the classified civil service. There shall be eleven (11) supervising inspectors, who shall be appointed by the Secretary of Commerce, in accordance with and under the provisions of the act of January 16, 1883, known as the Civil Service Act. The supervising inspector shall be entitled, in addition to his authorized pay and traveling allowances, to his actual and reasonable expenses for transportation of instruments, which shall be certified and sworn to under such instructions as shall be given by the Secretary of Commerce."

SEC. 2. That this act shall be effective on and after the date of its approval.

During the year I traveled through all of the districts, wherever possible accompanied by the supervising inspector. With him I took up questions that arose concerning the local boards, such as methods of inspection, personnel matters, administration, and so on. I held regional conferences on the Pacific coast with the two supervising inspectors of that region with a view to obtaining uniform procedure and eliminating differences in practice between supervising inspection districts. I followed this plan also at St. Louis, Mo., where I had with me the supervising inspectors of the fourth, sixth, and tenth districts, and on the Atlantic coast.

At the present time stability tests are made by two trav e ng inspectors, who have their headquarters at Washington. This work has increased to such an extent that it is absolutely necessary to have more inspectors. During the past year the pressure of stability work was such that we were unable to keep abreast of it and get our calculations finished so as not to delay vessels. In many instances measurements were taken after dark, necessarily creating a doubt of their accuracy. Three additional traveling inspectors are recommended for the fiscal year 1929. There are at present three traveling inspectors, one of whom is employed in the checking of equipment of vessels. Manifestly one man can not cover the whole of the United States effectively. If the additional men are allowed, we will be able to use two traveling inspectors for checking equipment, etc., and four to do the inclining work.

More men.—In the visits to the districts of this service, I have made careful investigations to determine whether the recommendations for increases in force that have so often been made to the central office were justified. I find that they are. In a number of districts, even with long hours, it is impossible to take care of the many reinspections that must be made in order to insure safe conditions and protect against disasters. The service is not engaged entirely in the inspection of vessels of the merchant marine and the licensing of officers. Work is done in the inspection of boilers for

other departments, in public buildings, cantonments, fortifications, and in many Government vessels. We should have increased personnel so as to facilitate the handling of the work. In the estimates for 1929, additional inspectors have been requested to be stationed at different ports, and it is my earnest plea that these additional inspectors be allowed.

Salaries.—The salary grades for inspectors are not high enough to compensate them for the work they do and to maintain the morale of the force. As rapidly as funds may be secured for the purpose, I recommend that the department approve the following schedule of pay for this service:

Supervising inspectors	$5, 200 to $6, 000
Traveling inspectors	3, 800 to 5, 000
Local inspectors	3, 800 to 5, 000
Assistant inspectors	3, 000 to 3, 600

Higher ranges should also be fixed for the clerical employees.

BOILERS AND MACHINERY

Reference was made in the last annual report to the matter of boiler inspection. In regard to the comparison of the rules of different classification societies with those of this service, some progress has been made, and I hope to be able to receive within a reasonable time a full report. It is apparent that it is necessary to bring up to date certain of the provisions in the general rules and regulations so far as they relate to valves, fittings, and piping. Late in the fall of this year I expect to have a conference with manufacturers, with a view to getting their cooperation in the revision of the present rules.

Something should be done to give the Board of Supervising Inspectors proper authority in regard to pressures of boilers. Reference has repeatedly been made, in previous annual reports, to changes that are desirable, and I submit below a suggested form of bill to amend sections 4433 and 4418, Revised Statutes (U. S. C., Title 46, secs. 411 and 392), which, if enacted into law, will give the Board of Supervising Inspectors the authority that it needs:

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That section 4433 of the Revised Statutes of the United States be, and the same is hereby, amended so as to read as follows:

"SEC. 4433. The working steam pressure allowable on all boilers in vessels which are required to be inspected under the laws of the United States shall be determined under and in accordance with such rules and regulations as the Board of Supervising Inspectors, with the approval of the Secretary of Commerce, shall hereafter establish in respect thereto."

SEC. 2. That section 4418 of the Revised Statutes of the United States as amended by the act of Congress approved March 3, 1905, be, and the same is hereby, amended so as to read as follows:

"SEC. 4418. The local inspectors, under such rules and regulations as the Board of Supervising Inspectors, with the approval of the Secretary of Commerce, shall hereafter establish in respect thereto, shall also inspect the boilers subject to steam pressure and all the attachments, connections, equipment, apparatus, and appurtenances thereof, on all vessels required to be inspected before the same shall be used and at least once in every year thereafter. No local inspector shall approve any such boilers or the attachments, connections, equipment, apparatus, or appurtenances thereof unless in his opinion they meet the requirements of said rules and regulations and may be safely used in the service proposed. The local inspectors shall also subject all such boilers to hydrostatic tests in accordance with such rules and regulations as the Board of Supervising Inspectors, with the approval of the Secretary of Commerce, shall hereafter establish in respect thereto."

SEC. 3. That this act shall take effect three months after its passage.

FIRE

Excursion steamers.—An examination of the rules and regulations will show that the Board of Supervising Inspectors has done constructive work in requiring fire-fighting equipment on vessels, but it seems to this office that the time is at hand when naval architects should give attention to the proposition of building excursion steamers that are fireproof. It is true that we provide pumps and fire extinguishers, lifeboats, and supposedly well-disciplined crews, but why not make the ships fireproof in the first instance? If excursion steamers were built with fireproof superstructures, we would have gone a long way toward getting safe conditions.

Detecting apparatus.—For some time this office has been working actively not only with the Board of Supervising Inspectors, which has been instructed to get the best suggestions of shipbuilders and operators, but with the underwriters and every possible agency in this country, with a view to formulating a rule that will result in something really constructive with respect to detecting apparatus. Much work has been done, and it is my hope that at the next meeting of the Board of Supervising Inspectors there may be a conference between the members of the board and the representatives of the leading maritime interests of this country, to the end that this matter may be settled satisfactorily.

MOTOR CRAFT

In the annual reports of the Supervising Inspector General the desirability of a change in the law with reference to the inspection of vessels propelled by power other than steam has been repeatedly stressed. It is necessary again to say that this question should receive attention. The motor-boat act of June 9, 1910, does not meet the situation. To issue a so-called operator's license under a law that expressly forbids us to examine the operator is ridiculous. The possession of such a license is misleading to every one. Every motor-boat operator should be examined as to his color sense, visual acuity, and his knowledge of the rules of the road.

STATISTICS

The force inspected and certificated 7,357 vessels, with a total gross tonnage of 15,312,621, of which 7,050 were domestic vessels, with a total gross tonnage of 12,165,143, and 307 were foreign passenger steam vessels, with a total gross tonnage of 3,147,478. Of the domestic vessels, there were 5,563 steam vessels, 1,005 motor vessels, 16 passenger barges, and 466 seagoing barges. There was a decrease of 20 in the total number of vessels inspected and an increase of 296,065 in the total gross tonnage of vessels inspected as compared with the previous fiscal year. There were 2,432 reinspections of steam vessels, motor vessels, and barges. There were 1,044 cargo vessels examined to carry persons in addition to crew under the act of Congress approved June 5, 1920. Letters of approval of designs of boilers, engines, and other operating machinery were granted to 8 steam vessels, with a total gross tonnage of 276. There were inspected for the United States Government 33 hulls of vessels and 2,188 boilers.

Licenses were issued to 24,161 officers of all grades. There were examined for visual defects 7,408 applicants for license, of whom 36 were found color blind or with other visual defects and rejected. Certificates of service were issued to 9,716 able seamen, and 786 were rejected. Certificates of efficiency were issued to 7,746 lifeboat men, and 4,688 were rejected.

Steel plates for the construction of marine boilers to the number of 3,263 were inspected at the mills. There were tested at the mills by assistant inspectors 2,298 steel bars to be used as boiler stays and braces, of which 15 were rejected. There were examined and tested 182,164 new life preservers, of which 1,960 were rejected. There were inspected at factories 9,196 new cork-ring life buoys, of which 171 were rejected; 581 new lifeboats, of which 2 were rejected; 209 new life rafts, all of which passed; and 220 new boat davits, all of which passed.

The total number of accidents resulting in loss of life was 211. The total number of lives lost was 262, of which 48 were passengers. Of the lives lost, 146 were from suicide, accidental drowning, and other similar causes, leaving a loss of 116 fairly chargeable to accidents, collisions, founderings, etc. There was a decrease of 106 in the number of lives lost as compared with the previous fiscal year.

Passengers to the number of 339,447,052 were carried on vessels required by law to make report of the number of passengers carried. Dividing this number by 48, the total number of passengers lost, shows that 7,071,813 were carried for each passenger lost. The number of lives directly saved by means of the life-saving appliances required by law was 397.

Very truly yours,

DICKERSON N. HOOVER,
Supervising Inspector General.

PATENT OFFICE

DEPARTMENT OF COMMERCE,
UNITED STATES PATENT OFFICE,
Washington, July 1, 1927.

Hon. HERBERT HOOVER,
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, 1927:

Measured by the number of applications received in the office for patents, designs, trade-marks, etc., the year just closed is the greatest in the history of the Patent Office, slightly exceeding the year 1922 and exceeding the year 1926 by 3,700 cases and the year 1925 by 10,000 cases. Unfortunately, owing to a decrease of over 50 examiners, this year of tremendous receipts has resulted in the office going much further behind in part of its work, thereby decreasing the "output." While both the trade-mark and design divisions are current, acting on new cases within 30 days and on amended cases within 15 days, cases awaiting official action in the patent divisions have increased from 43,765 to 64,646—over 20,000.

A year ago 12 patent divisions were acting on cases within 2 months after they were filed, and none were in excess of 5 months, with an average of 2½ months. Now not one of the patent divisions is under 3 months behind, and some are more than 6 months behind, the average arrearages being 3½ months. With the number of new applications jumping from 103,591 in 1925 to 113,783 in 1927, it follows that the office must have a large increase in force in order to give the public the service for which it pays. This is emphasized by the fact that when the office is behind in its work it is a continual drag on the industries of the country. For 1928 the Patent Office has been given an increase of two divisions, or about 30 employees, but even with this increase it will have fewer examiners than in 1925 and 1926, during which the arrearages were reduced from 74,000 to 43,000 cases. In order to successfully cope with the work, this office should have five divisions additional to the two referred to. The force now authorized will hardly be sufficient even to act upon the current cases as rapidly as filed and will certainly not be sufficient to reduce the number of cases already piled up on the desks of the various examiners—which now aggregate 64,000. The examiners are getting out as large a number of cases per man as can be done with safety. Relief can be obtained only by a larger force. The office should be so manned that the cases awaiting action may be reduced to not more than 15,000, when it would be possible to act upon patent cases as promptly as the cases are handled in the trade-mark and design divisions—within 30 days on new cases and within 15 days on amended cases.

The work of the various clerical divisions is, as its character vitally requires it to be, practically up to date. Previous to the last fiscal year, when the assignments had to be recorded by the typewriting method, the assignment division was from 45 to 60 days in arrears. Under the photostatic method of recording assignments recently installed, assignments are now recorded and returned within 15 days. It is gratifying to report that throughout the office, except in the examining divisions, the work has never been in a more satisfactory condition nor has the physical condition of the building and equipment been better. The stock of copies—patents and trade-marks, aggregating 74,000,000 copies, having a cost value of about $4,000,000 and a sale value of over $7,000,000—is kept in as nearly perfect shape as it can be with a large number of the copies still on wooden shelves and on six different floor levels. The policy of the Bureau of the Budget and of the appropriation committees in making appropriations gradually to place these copies on steel shelves is decidedly economical. Although the office is disposing of 50 per cent more copies than in 1921, when the work of installing the steel stacks was begun, the work of pulling and distributing copies for sale is being accomplished without any increase in force. This is a great saving, and it is recommended that the rest of the steel stacks be appropriated for as rapidly as possible.

In February and March Congress passed new legislation for the Patent Office which changed the fees and the method of appeals within the office. Hereafter an applicant who files an application with a large number of claims will be charged $1 extra for each claim in excess of 20 when the case is filed and also when printed.

The bill changing the course of appeals went into effect on May 2, so that henceforth there will be only one appeal within the office instead of two as heretofore. While this will not expedite the work in the examining divisions, it will considerably shorten the time a case is pending on appeal.

During the past year all the patents in the public search room, amounting to between 2,000,000 and 3,000,000 copies, including cross references, have been checked up, and copies which have been lost or misplaced have been supplied.

RESIGNATIONS

During the year the office has continued to suffer from the number of separations of highly trained employees from the examining corps. These totaled 104—98 by resignation, 4 by retirement, and 2 by death; 98 resignations out of a force of less than 500 is such a drain upon the scientific corps of this office as to seriously cripple the force, lower the effective output of the office, and impair the quality of the work. Their services were of very great value to the office. Most of those who have resigned were experienced men. In the main they leave the Patent Office to accept more lucrative employment outside the Government. To give a professional man, scientifically and legally educated, an intensive training for several years in our particular work and then to permit him to resign merely because he is paid an insufficient salary is not only false economy but entails

large economic loss. In this connection the recent statement of a Member of the present Congress is in point, to wit:

"* * * it is even more foolish economy to pay inadequate salaries to men intrusted with such important work."

The committee of lawyers, engineers, and scientists, appointed by Secretary Work and continued by Secretary Hoover, made as one of its recommendations that the principal examiners should be placed in professional grade 5. If this were done, it would stabilize the force and make the positions so much more attractive that we would have fewer resignations.

STATISTICS

Following is the usual statistical report.

Applications received during the fiscal year ended June 30, 1927 [1]

With fees:		
Applications for patents for inventions	84,511	
Applications for patents for designs	4,421	
Applications for reissues of patents	428	
		89,360
Applications for registration of trade-marks	[2] 21,053	
Applications for registration of labels	2,111	
Applications for registration of prints	1,259	
		24,423
Total, with fees		113,783
Without fees:		
Applications for inventions (act Mar. 3, 1883)	76	
Application for reissue under rule 170	1	
		77
Grand total		113,860

Applications for patents for inventions with fees

Year ended June 30—		Year ended June 30—	
1918	62,399	1923	77,645
1919	62,755	1924	76,024
1920	81,948	1925	77,926
1921	84,248	1926	80,682
1922	88,243	1927	84,511

Applications for patents, including reissues, designs, trade-marks, labels, and prints with fees

Year ended June 30—		Year ended June 30—	
1918	73,307	1923	100,724
1919	75,657	1924	99,574
1920	102,940	1925	103,591
1921	107,656	1926	110,030
1922	113,597	1927	113,783

Patent applications awaiting action

June 30—		June 30—	
1918	14,769	1923	72,475
1919	17,735	1924	60,334
1920	34,355	1925	44,556
1921	49,334	1926	43,765
1922	67,367	1927	64,646

[1] Including applications in which fees were refunded and transferred.
[2] Includes 3,550 applications for the renewal of trade-mark registration.

66698—27†——17

Patents withheld and patents expired

	1926	1927
Letters patent withheld for nonpayment of final fees	10,048	9,436
Applications allowed awaiting payment of final fees	15,918	15,684
Patents expired	34,332	36,308
Applications in which issue of patent has been deferred under sec. 4885, R. S.	168	124
Applications in process of issue	3,063	3,027

Patents granted and trade-marks, labels, and prints registered

	1923	1924	1925	1926	1927
Letters patent	39,004	38,963	45,218	46,464	43,244
Design patents	1,452	2,443	2,692	2,763	2,478
Reissue patents	255	228	237	268	293
Trade-marks	13,169	16,203	14,542	14,236	14,858
Labels	1,549	1,350	1,400	1,676	1,782
Prints	592	666	615	868	1,074
Total	56,021	59,853	64,704	66,275	63,729

Statement of receipts and earnings for the fiscal year ended June 30, 1927

Unearned balance at close of business June 30, 1926			$150,204.08
Receipts for fiscal year ended June 30, 1927		$3,491,655.55	
Receipts, sale of Official Gazette and other publications through Government Printing Office		32,500.00	
			3,524,155.55
			3,674,359.63
Earnings:			
Inventions	$1,686,655.00		
Extra claims	7,212.00		
Reissues	12,650.00		
Designs	51,310.00		
Design extensions	13,910.00		
Trade-marks	208,049.00		
Labels and prints	17,154.00		
		1,996,940.00	
Final fees	862,120.00		
Extra claims	2,056.00		
		864,176.00	
Appeals	30,475.00		
Oppositions	7,230.00		
Disclaimers	590.00		
		38,295.00	
Printed copies, etc	328,375.23		
Photoprints	11,617.15		
Photostats	44,365.75		
Manuscript copies	63,304.20		
Certified printed copies, etc	8,474.49		
Recording articles of incorporation	598.00		
Recording international trade-marks	300.00		
Registration of attorneys	725.00		
		457,759.82	
Drawings		21,188.84	
Assignments		86,272.75	
Total		3,464,632.41	
Receipts from sale of Official Gazette, etc		32,500.00	
			3,497,132.41
Refunded			25,330.92
Unearned balance June 30, 1927			151,896.30
			3,674,359.63

Expenditures, fiscal year ended June 30, 1927

Salaries		$2,417,727.86
Salaries, additional employees		24,949.19
Scientific library		7,800.00
Investigating public use		670.72
Photolithographing:		
Current issue	$62,408.24	
Reproductions	97,529.27	
Photographic printing	17,935.17	
Photostat supplies	41,366.30	
Dry mounts	2,719.36	
Total		221,958.34
Printing and binding:		
Specifications	724,963.16	
Official Gazette	235,861.48	
Indexes	16,486.36	
Total		977,311.00
Miscellaneous		55,000.00
Furniture and filing cases		19,986.00
Contingent expenses, including telephones, stationery, postage on foreign mail, etc		25,700.92
Public search room		18,500.00
Total		3,769,604.03

Receipts and expenditures

Total receipts from all sources	$3,524,155.55
Expenditures	3,769,604.03
Deficit	245,448.48
Total net surplus to date	7,082,400.50

Comparative statement

June 30—	Receipts	Expenditures	Surplus
1918	$2,103,660.56	[1] $2,131,616.18	−$27,955.62
1919	2,113,350.17	[1] 2,178,578.30	−65,228.13
1920	2,615,697.33	[1] 2,436,561.37	179,135.96
1921	2,712,119.69	[1] 2,640,373.96	71,745.73
1922	2,894,286.58	[1] 2,722,205.37	172,081.21
1923	3,026,486.36	[1] 3,112,022.07	−85,535.71
1924	3,042,276.22	[1] 3,273,341.37	−231,065.15
1925	3,271,253.89	3,775,476.97	−504,223.08
1926	3,457,774.53	3,857,952.11	−400,177.58
1927	3,524,155.55	3,769,604.03	−245,448.48

[1] Including increase in compensation (bonus).

Litigated cases

Oppositions instituted	811
Cancellations instituted	193
Interferences declared (including 259 trade-mark)	1,731
Interferences heard (including 340 trade-mark)	563
Interferences disposed of before final hearing (including 1,015 trade-mark)	2,225
Interferences disposed of after final hearing (including 281 trade-mark)	539
Interferences awaiting decision (including 60 trade-mark)	97

Oldest case awaiting action, Mar. 3, 1927.

To board of appeals:	
Appeals in interference cases	330
Ex parte appeals	1,659
	1,989
Appeals in interference cases disposed of	270
Ex parte appeals disposed of	1,240
	1,510
Interference cases awaiting action	248
Ex parte cases awaiting action	1,418
	1,666

Oldest interference case awaiting action, May 3, 1927.
Oldest ex parte case awaiting action, May 2, 1927.

To the commissioner:	
Appeals in interference cases (including 14 trade-mark)	124
Appeals in opposition cases	77
Appeals in cancellation cases	17
Ex parte appeals	269
Interlocutory appeals	238
Ex parte appeals in trade-mark cases	20
Total	645
Petitions	4,566
Total	5,211
Cases disposed of by commissioner:	
Appeals in interference cases (including 7 trade-mark)	82
Appeals in opposition cases	53
Appeals in cancellation cases	10
Ex parte appeals	216
Interlocutory appeals	202
Ex parte appeals in trade-mark cases	17
Total	580
Petitions to commissioner	4,566
Total	5,146
To Court of Appeals of the District of Columbia:	
Appeals in ex parte cases (including 1 trade-mark)	42
Appeals in interference cases (including 6 trade-mark)	48
Appeals in opposition cases	28
Appeals in cancellation cases	12
Total	130

OTHER DETAILS OF BUSINESS FOR THE FISCAL YEAR

As to the volume of business, the office received during the year 89,360 applications for patents, reissues, and designs; 17,503 trade-mark applications and 3,550 applications for renewal of trade-mark registrations; 3,370 label and print applications; 208,841 amendments to patent applications, 6,569 amendments to design applications, and 23,757 amendments to trade-mark, label, and print applications.

The number of letters constituting the miscellaneous correspondence received and indexed was 359,948. In addition, 43,248 letters were returned with information.

The number of printed copies of patents sold was 3,204,532; 1,220,035 copies of patents were shipped to foreign governments and 685,621 copies furnished public libraries. The total number of copies of patents furnished was 5,531,957, including those for office use and other departments.

The office received for record 46,308 deeds of assignment.

Typewritten copies of 11,248,800 words were furnished at 10 cents per hundred words. The office certified to 10,509 manuscript copies and furnished 9,612 miscellaneous certified copies. The office also furnished 223,291 photostat copies of manuscript pages, 65,807 photographic copies, and 266,315 photostat copies of publications and foreign patents, for sale; 4,257 photostat-manuscript pages, 59 certified manuscript copies, and 3,083 photostat copies for Government departments, without charge; 23,462 photostat and 16,983 photographic copies for use of the Patent Office; 10,048 photostat copies for photoprint section, Patent Office; in all, 530,456 photostat and 82,790 photographic copies.

Very truly yours,

THOMAS E. ROBERTSON,
Commissioner of Patents.

BUREAU OF MINES

DEPARTMENT OF COMMERCE,
BUREAU OF MINES,
Washington, July 1, 1927.

HON. HERBERT HOOVER,
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, 1927:

DUTIES

It is customary to preface the annual report of the Bureau of Mines with a quotation from the organic act of May 16, 1910, as amended February 25, 1913, creating the bureau and defining its powers and duties. The act reads in part as follows:

> That there is hereby established * * * a bureau of mining, metallurgy, and mineral technology, to be designated the Bureau of Mines. * * * That it shall be the province and duty of the Bureau of Mines * * * to conduct inquiries and scientific and technologic investigations concerning mining, and the preparation, treatment, and utilization of mineral substances with a view to improving health conditions, and increasing safety, efficiency, economic development, and conserving resources through the prevention of waste in the mining, quarrying, metallurgical, and other mineral industries; to inquire into the economic conditions affecting these industries; to investigate explosives and peat; and on behalf of the Government to investigate the mineral fuels and unfinished mineral products belonging to, or for the use of, the United States, with a view to their most efficient mining, preparation, treatment, and use; and to disseminate information concerning these subjects in such manner as will best carry out the purposes of this act. * * * That the director of said bureau shall prepare and publish * * * reports of inquiries and investigations, with appropriate recommendations of the bureau, concerning the nature, causes, and prevention of accidents, and the improvement of conditions, methods, and equipment, with special reference to health, safety, and prevention of waste in the mining, quarrying, metallurgical, and other mineral industries; the use of explosives and electricity, safety methods, and appliances, and rescue and first-aid work in said industries; the causes and prevention of mine fires; and other subjects included under the provisions of this act.

FINANCES AND FINANCIAL HISTORY

The financial history of the bureau since its organization in 1910 is summarized in Table 1. Footnotes explain the large nonoperating items, such as initial cost of Government fuel yards plant, war minerals relief, helium operations, and others representing services rendered to other departments of the Government. The first column shows direct appropriations; the second column shows departmental allotments for printing and binding and for supplies and equipment for the bureau's Washington office; the third column, funds transfer-

red from other departments, includes only transfers to cover the actual cost of services performed for such departments. The unexpended balance column shows the sums of money returned to the Treasury of the United States. Total annual expenditures are next listed. The final column shows expenditures by the bureau, but does not include service items for others; figures in it have been used to plot Figure 1. This last column and the curve (fig. 1) may be regarded as measuring the bureau's activity in the performance of its regular functions and duties, as stated in the organic act; this curve includes, subsequent to 1925, mineral resources funds, transferred in 1926 from the Geological Survey budget, after the transfer of the Bureau of Mines from the Department of the Interior to the Department of Commerce on July 1, 1925. The table, except for appropriations, is necessarily complete only through June 30, 1927, but such allotments and transfers as were known at the beginning of the fiscal year 1928 have also been included.

TABLE 1.—*Bureau of Mines appropriations and expenditures, fiscal years ended June 30, 1911–1927*

Fiscal year	Appropriated to Bureau of Mines	Departmental allotments [1]	Funds transferred from other departments	Total funds available for expenditure	Unexpended balances	Total expenditures	Expenditures exclusive of service items [2]
1911	$502,200.00	$34,200.00		$536,400.00	$22,818.27	$513,581.73	$513,581.73
1912	475,500.00	45,640.00		521,140.00	6,239.77	514,900.23	514,900.23
1913	583,100.00	47,850.00		630,950.00	4,087.20	626,862.80	626,862.80
1914	664,000.00	57,307.79		721,307.79	4,678.29	716,629.50	716,629.50
1915	730,500.00	55,424.60		785,924.60	4,178.11	781,746.49	781,746.49
1916	757,300.00	48,710.87		806,010.87	9,058.63	796,952.24	796,952.24
1917	981,060.00	52,400.00		1,033,460.00	48,588.10	984,871.90	984,871.90
1918	1,467,070.00	51,901.98	[3] $3,062,000.00	4,580,971.98	395,745.10	4,185,226.88	1,172,939.64
1919	[4] 3,245,285.00	49,542.86	[5] 8,600,000.00	11,894,827.86	2,452,236.78	9,442,591.08	1,137,471.37
1920	1,216,897.00	52,800.00		1,269,697.00	9,592.18	1,260,104.82	1,245,891.36
1921	1,362,642.00	62,618.72	666,720.00	2,091,980.72	13,985.89	2,077,994.83	1,412,923.15
1922	1,474,300.00	59,800.00	182,200.00	1,716,300.00	52,120.45	1,664,179.55	1,483,038.47
1923	1,580,900.00	70,814.30	97,100.00	1,748,814.30	10,959.08	1,737,855.22	1,640,840.57
1924	1,784,959.00	50,710.00	347,820.00	2,183,489.00	38,085.43	2,145,403.57	1,804,800.41
1925	2,028,268.00	57,500.00	236,465.86	2,322,233.86	107,743.20	2,214,490.66	1,998,669.20
1926	1,875,010.00	81,220.00	510,501.15	2,466,731.15	[6] 59,251.23	2,407,479.92	[7] 1,810,931.42
1927	1,914,400.00	94,443.39	325,000.00	2,333,843.39	[8] 6,367.28	2,327,476.11	[9] 1,930,738.37
Total	22,643,391.00	972,884.51	14,027,807.01	37,644,082.52	3,245,734.99	34,398,347.53	20,573,788.85
1928	2,975,150.00	97,060.00	200,000.00	3,272,210.00			[10] 1,934,210.00

[1] Includes printing and binding, stationery, and contingent.
[2] Service items include Government fuel yards, helium, and other investigations and services for other departments.
[3] Gas investigations for War Department.
[4] Includes $1,586,388 for Government fuel yards.
[5] War Minerals Relief Commission, $8,500,000.
[6] Subject to adjustment until June 30, 1928.
[7] Includes $122,229.39 for mineral resources originally budgeted to Interior Department.
[8] Subject to adjustment until June 30, 1929.
[9] Includes $122,776.20 for mineral resources.
[10] Appropriations, allotments, and transfers (exclusive of service items) as of July 1, 1927.

From the above it is evident that for the fiscal year July 1, 1926, to June 30, 1927, the bureau had a total allotment of funds amounting to $2,333,843.39; of this allotment $2,327,476.11 was expended and $6,367.28 was returned to the Treasury. On the regular work of the bureau $1,930,738.37 was expended directly; in addition, on the helium program, service work for the Army and Navy, $75,000 was budgeted directly to the bureau and $325,000 was transferred from the Army

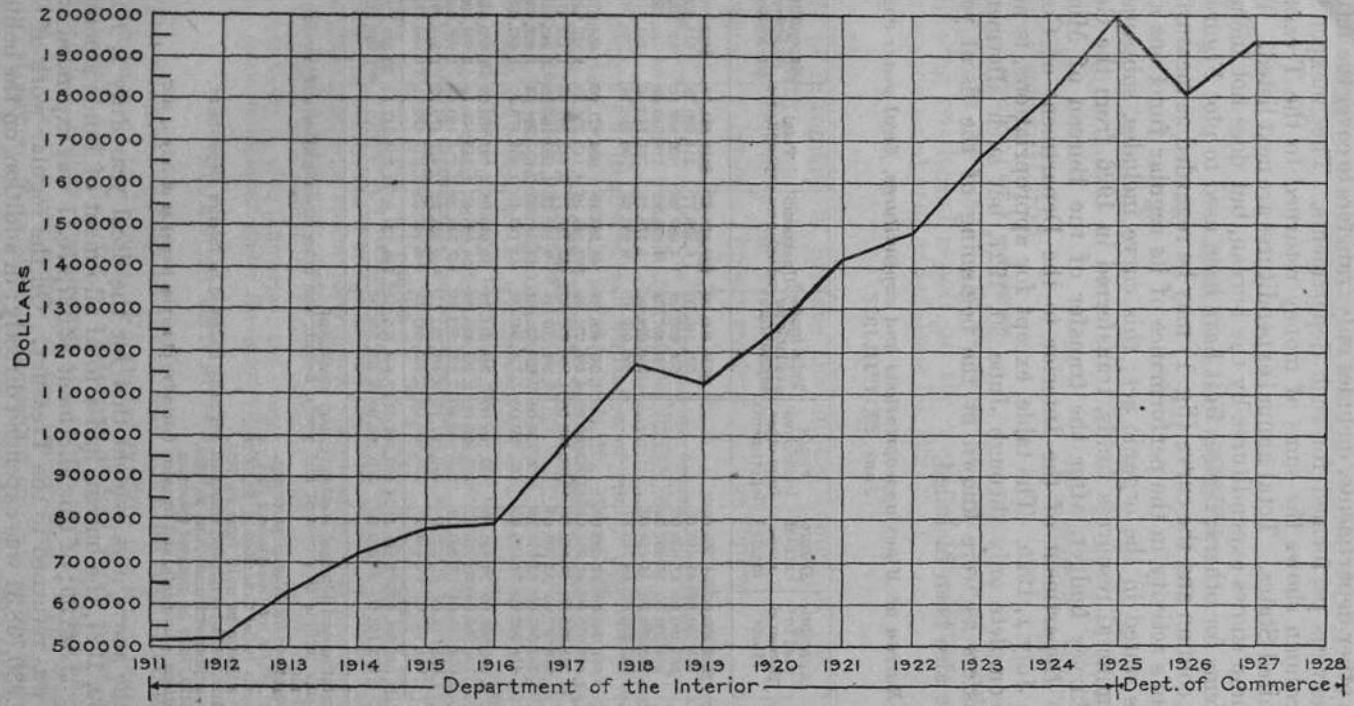


FIG. 1.—Curve of annual expenditures of Bureau of Mines since its organization (exclusive of service items)

and Navy. The next largest strictly service work is that done by the Government fuel yards, which operates on a revolving fund and handled material of a total sales value of $1,581,099.21, although this work has no direct bearing on the conduct of regular Bureau of Mines affairs. The curve shown in Figure 2 is a plot of all expenditures of the bureau since its establishment and includes regular appropriations, service items, all departmental allotments, and transferred funds from all sources.

Money spent by branches during fiscal year 1926–27

Item	Amount	Per cent
Technologic	$1,504,544.56	64.7
Economic	219,353.19	9.4
Health and safety	335,193.32	14.4
Administrative and general (including experimental mine, Washington office, chief engineer's office, etc.)	268,385.04	11.5
Total	2,327,476.11	100.0

ANALYSIS OF EXPENDITURES IN 1926–27

Table 2 shows expenditures according to congressional appropriations by the bureau and to branches and divisions in the light of the internal administrative organization of the bureau. To one at all familiar with the scope and activities of the bureau, this table gives information as to the exact and relative size of work carried on during the year, since expenditures are closely indicative of size of personnel and hence are a measure of activity of each division.

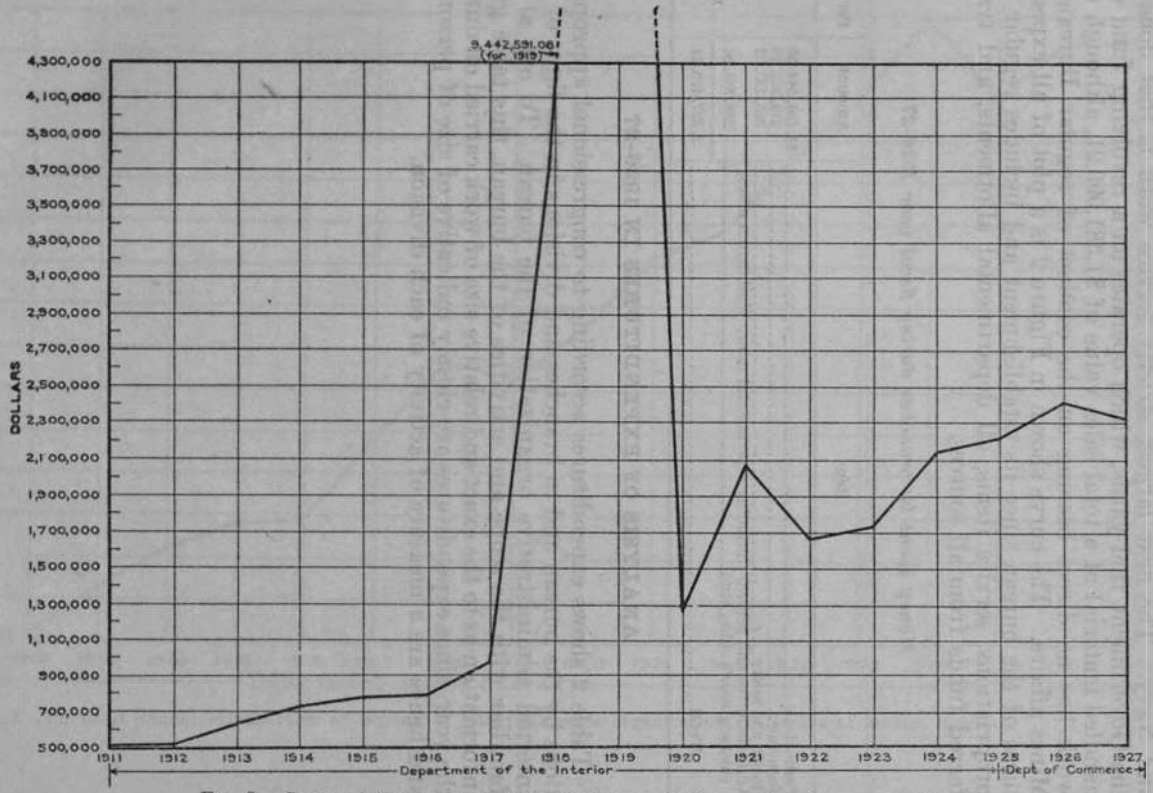


FIG. 2.—Curve of total expenditures of Bureau of Mines since its organization

TABLE 2.—*Bureau of Mines expenditures, fiscal year 1927*

Branch or division	General expenses	Mine accidents	Testing fuel	Mineral mining	Mining investigations in Alaska	Mineral resources	Oil-shale investigations	Oil, gas, and oil-shale investigations	Helium investigations
Office of the director	$10,727.81								
Office of the assistant to the director	6,667.26								
Office of the chief mining engineer		$46,790.80							
Administrative branch:									
Information division	35,374.01	23,408.91	$7,389.77	$645.77					
Office administration division	31,639.99	20,352.12	8,116.89	4,078.65		$7,277.81	$4,980.00	$5,876.07	$7,726.65
Total	67,014.00	43,761.03	15,506.66	4,724.42		7,277.81	4,980.00	5,876.07	7,726.65
Technologic branch:									
Experiment stations division		54,385.31	20,118.56	7,789.50					874.14
Explosives division		66,981.40							
Helium division									65,356.25
Mechanical division		77,894.54	117,859.75						
Metallurgical division				72,888.25					
Mining division		33,306.29		19,784.19	$10,803.36				
Petroleum and natural-gas division							83,903.52	197,571.76	
Total		232,567.54	137,978.31	100,461.94	10,803.36		83,903.52	197,571.76	66,230.39
Economics branch:									
Coal division				16,973.62		20,995.00			
Minerals division				18,347.89		4,502.63			
Mineral resources and statistics division		15,192.49		1,634.99		75,860.76			
Petroleum and natural-gas division				4,789.80		14,140.00		7,218.23	
Government fuel yards									
Total		15,192.49		41,746.30		115,498.39		7,218.23	
Health and safety branch:									
Health division		57,609.09		747.35					
Safety division		7,336.88		492.03					
Total		64,945.97		1,239.38					
Total appropriations	84,680.00	403,500.00	154,000.00	148,660.00	10,860.00	123,000.00	89,000.00	211,000.00	75,000.00
Total expenditures	84,409.07	403,257.83	153,484.97	148,172.04	10,803.36	122,776.20	88,883.52	210,666.06	73,957.04
Unexpended balance	270.93	242.17	515.03	487.96	56.64	223.80	116.48	333.94	1,042.96

TABLE 2.—*Bureau of Mines expenditures, fiscal year 1927*—Continued

Branch or division	Care, etc., buildings and grounds, Pittsburgh	Maintenance and operation fuel yards	Operating mine-rescue cars and stations	Expenses, mining experiment stations	Potash investigations	Helium conservation, production, and exploitation	Printing and binding	Department contingent	Total
Office of the director									$10, 727. 81
Office of the assistant to the director									6, 667. 26
Office of the chief mining engineer							$1, 448. 78		48, 239. 58
Administrative branch:									
Information division							1, 146. 73		67, 965. 19
Office administration division			$6, 592. 30	$2, 864. 17		$4, 780. 00	2, 642. 22	$27, 858. 33	134, 785. 20
Total			6, 592. 30	2, 864. 17		4, 780. 00	3, 788. 95	27, 858. 33	202, 750. 39
Technologic branch:									
Experiment stations division	$64, 262. 45		6, 620. 00	7, 879. 04			2, 339. 00		164, 268. 00
Explosives division							117. 46		67, 098. 86
Helium division						318, 000. 70	183. 25		383, 540. 20
Mechanical division							720. 12		196, 474. 41
Metallurgical division				161, 726. 36			6, 613. 53		241, 228. 14
Mining division					$100, 000. 00		4, 728. 22		168, 622. 06
Petroleum and natural-gas division							1, 837. 61		283, 312. 89
Total	64, 262. 45		6, 620. 00	169, 605. 40	100, 000. 00	318, 000. 70	16, 539. 19		1, 504, 544. 56
Economics branch:									
Coal division							4, 219. 77		42, 188. 39
Minerals division							2, 145. 63		24, 996. 15
Mineral resources and statistics division							33, 332. 38		126, 020. 62
Petroleum and natural-gas division									26, 148. 03
Government fuel yards		(1)							
Total							39, 697. 78		219, 353. 19
Health and safety branch:									
Health division							3, 939. 04		62, 295. 48
Safety division			263, 939. 28				1, 129. 65		272, 897. 84
Total			263, 939. 28				5, 068. 69		335, 193. 32
Total appropriations	64, 320. 00	(1)	277, 380. 00	173, 000. 00	100, 000. 00	325, 000. 00	66, 543. 39	27, 900. 00	2, 333, 843. 39
Total expenditures	64, 262. 45		277, 151. 58	172, 469. 57	100, 000. 00	322, 780. 70	66, 543. 39	27, 858. 33	2, 327, 476. 11
Unexpended balance	57. 55		228. 42	530. 43		2, 219. 30		41. 67	6, 367. 28

[1] Revolving fund.

PROPERTY

The books of the bureau, as of May 31, 1927, show property accounts as follows:

Nonexpendable property

Real estate	$1,027,591.94	Hardware	$21,662.59
Laboratory	336,918.97	Household	13,875.56
Special equipment	316,204.90	Medical	11,462.05
Office furniture	270,556.89	Drafting	6,959.92
Power plant	206,976.11	Canvas	3,311.25
Automotive	50,491.73		
Electrical	47,106.55	Total	2,335,848.74
Photographic	22,730.28		

The bureau books show the geographical distribution of this property, divided among 29 locations, ranging in amount from $216.60 at Moscow, Idaho, to $1,424,051.01 at Pittsburgh, Pa.

In addition, there is a stock on hand of expendable property, not listed in detail, which is comparatively small in total amount.

The bureau occupies, in 32 localities, a total of 564,430 square feet of office, laboratory, power-plant, warehouse, garage, and other space; it owns all the surface and some mining rights in 78 acres of coal land at Bruceton, Pa.

WORK OF INFORMATION DIVISION

Although the output of the bureau can not be correctly measured by the number of its own publications, because of shortage of printing funds, the table following shows by fiscal years the number and character of bureau publications since 1922.

TABLE 3.—*Bulletins, technical papers, circulars, and other publications issued through the Government Printing Office, fiscal years 1922–1927*

Publications	1922	1923	1924	1925	1926	1927
Bulletins	6	14	13	13	11	23
Technical papers	19	32	21	20	20	29
Miners' circulars	1	------	1	------	------	------
Annual report	1	1	1	1	1	1
List of publications	1	1	1	1	1	1
Index of publications	1	------	1	1	1	1
Handbooks	1	------	1	------	------	------
Schedules	3	3	1	------	2	3
List of moving-picture films	------	------	------	1	1	1
Mineral resources, separate chapters	------	------	------	------	44	66
Mineral resources, bound volumes	------	------	------	------	------	2
Other publications	10	4	------	------	------	2
REPRINTS						
Bulletins	------	7	------	1	------	------
Technical papers	2	14	3	2	------	1
Miners' circulars	1	------	6	8	8	------
Other publications	5	7	5	5	4	4

Only a part of the printed output of the bureau is handled in the manner indicated. It is necessary to make use of the mimeograph, the technical press, publications of technical societies, cooperative publications with outside agencies, and of many other methods; otherwise the results of bureau work will not be generally available to the industries concerned.

During the fiscal year ended June 30, 1927, printing funds were expended as follows:

Printing fund allotted by the department, distributed by divisions in the bureau during fiscal year 1927

Office of the chief mining engineer	$1,448.78
Administrative branch:	
Information division	1,146.73
Office administration division	2,642.22
Technologic branch:	
Experiment stations division	2,339.00
Explosives division	117.46
Helium division	183.25
Mechanical division	720.12
Metallurgical division	6,613.53
Mining division	4,728.22
Technologic branch—Continued.	
Petroleum and natural-gas division	$1,837.61
Economics branch:	
Coal division	4,219.77
Minerals division	2,145.63
Mineral resources and statistics division	33,332.38
Health and safety branch:	
Health division	3,939.04
Safety division	1,129.65
	66,543.39

As Table 3 shows, a total of 129 printed reports was issued during the year, including 23 bulletins, 29 technical papers, and 66 chapters of Mineral Resources of the United States. The mimeographed publications included 56 reports of investigations and 34 information circulars.

During the fiscal year the Bureau of Mines distributed 344,142 copies of the free editions of its printed publications—33,631 bulletins, 39,799 miners' circulars, 52,717 technical papers, 2,752 annual reports, 118,438 separate chapters of Mineral Resources of the United States, and 96,805 miscellaneous documents, largely popularly written manuals of instruction in first-aid and mine-rescue methods. Approximately 130,000 copies of the brief mimeographed publications, known as reports of investigations and information circulars, were also distributed free of charge. Their purpose is to give as promptly as possible to the mining industry and the general public the results of investigations that later are described in detail in the printed reports. In all, about 75,000 copies of the bureau's printed reports were sold during the year by the Superintendent of Documents at the actual cost of printing.

Approximately 100,000 letters requesting publications or information are received by the information division annually. They come from Government officials, Members of the Congress, and operators interested in safe and efficient mining, from miners seeking knowledge which may make safer their daily toil or will enable them to take examinations for promotion, from manufacturers interested in fuels, from housekeepers desiring to run their heating furnaces more efficiently, from prospectors, college students, school-teachers and their pupils, women's clubs, commercial organizations, writers, editors, and others. In order that these thousands of inquiries may be answered promptly much attention is given to indexing publications of the different branches of the Federal Government, foreign governments, State governments, educational institutions, and scientific societies, and the trade and technical journals.

SERVICE WORK

There is a natural tendency to change the bureau's investigative work into service work. As a result of research, trial, or experiment,

new ideas for more advantageous or economical methods are developed, and the bureau is called upon to put these results into practice along service lines. There are many examples of this in the bureau, such as testing electrical machinery for approval (an outgrowth of research on the use of electricity in mines and requiring much of the time of the bureau's electrical engineers); analysis of coals for purchase by the Government, a result of fuel studies; power, heating, and lighting installations, particularly in the District of Columbia, a result of the bureau's studies of the utilization of coal; service at mines in times of fire or disaster, an outcome of the bureau's studies of mine accidents; determination of the explosibility of particular coal dusts, as developed through the bureau's work in laboratories and the experimental mine, and the permissible explosive system, which involves much routine service work and is built on the bureau's studies of the safe use of explosives. Any money received for such services is returned to the Treasury and is not available for use by the bureau; in this way investigative appropriations are reduced and experimental work is curtailed.

The two largest strictly service units of the bureau are the fuel yards and the helium division. The Government fuel yards, which in the organization chart are a section in the coal division of the economics branch, handle the most money. The fuel yards purchase and stock coal, and distribute it to all Federal and District Government buildings and establishments (except the Washington Navy Yard) in the District of Columbia and to such other institutions outside the District as can be economically reached. The bureau maintains its own garage and 35 trucks of a total capacity of 215 tons; its coal yards have a storage capacity of more than 13,000 tons of coal. During 1927 coal aggregating 262,000 tons was delivered to more than 600 points; the trucks traveled 188,592 miles, or an average round-trip haul of 6.45 miles; the total cost of delivery was 17.4 cents per ton-mile. The sales value of coal delivered in 1927 was $1,550,651.85, as compared to $1,585,715.48 in 1926. These sums are a measure of the magnitude of the service work handled by this section of the bureau's coal division.

The helium service work of the bureau may be briefly described as follows: Before the United States entered the World War helium had been obtained only in small amounts as a curiosity in scientific laboratories. The total quantity recovered probably did not exceed 100 cubic feet, and the cost of production was $1,700 to $2,000 per cubic foot. Hence, although the possibility of helium as a lifting gas for aircraft was known, practical use seemed impossible. During the war a process for recovering helium from natural gas was developed through cooperation of the Army, Navy, Bureau of Mines, and the Linde Air Products Co. A helium production plant erected at Fort Worth, Tex., under contract with the Linde company, was put in operation in October, 1922, and since then inert helium, instead of inflammable hydrogen, has been used in the lighter-than-air craft of the War and Navy Departments. The plant was under the control of the Navy Department until June 30, 1925, when all Government activities relating to the production and conservation of helium were placed under the jurisdiction of the Bureau of Mines pursuant to the act of Congress approved March 3, 1925. During the fiscal year ended June

30, 1926, the plant produced 9,355,623 cubic feet of helium at an operating cost of $318,526, or 3.41 cents per cubic foot. Because of the approaching exhaustion of the Petrolia field—the source of the helium-bearing gas now used—production for the fiscal year ended June 30, 1927, declined to 6,330,056 cubic feet. The operating cost for the year was only $276,866, but the low production caused the cost per unit to rise to 4.37 cents per cubic foot, in spite of improvements and economies in plant operation. The Bureau of Mines is now developing a project for the use and conservation of helium-bearing natural gas from other sources. This project will enable the bureau to supply helium for the needs of the War and Navy Departments in larger quantities and at a lower cost per unit.

ORGANIZATION

The major subdivisions of the bureau and the titles of the heads of each are as follows:

Branch	Chief.
Division	Chief engineer.
Section	Supervising engineer.
Unit	Engineer in charge.

The bureau is divided into four branches—the technologic, economic, health and safety, and administrative. Within these branches is a total of 15 divisions, 80 sections, 61 units, and 1 office. Some experiment stations are similarly divided as to administrative organization.

The technologic studies of the bureau are conducted largely in the technologic branch, under the administrative and technical control of various divisions in that branch. A group of experiment stations, scattered widely over the country, study mining and metallurgical problems of special interest to their locality. This group is administered in the division of experiment stations.

Investigations in metallurgy are conducted in the field and at the experiment stations, under direction of a chief engineer, metallurgical division. Problems of fuels, their constitution and use, are handled by the mechanical division, which also considers mining machinery and especially the use of electricity in mining. The division of petroleum and natural gas deals with the production, transportation, refining, and use of these products. Its laboratory problems are conducted largely at Bartlesville, Okla., and field studies are carried on in every major producing field. An explosives division deals with the safe use of explosives and the establishment of a list of permissible explosives.

The production of helium for the Army and Navy is a service performed by the helium division, with production plants in the field and research laboratories at the bureau stations. Results of the work of the branch appear largely in Government publications and the technical press.

The economics branch was organized January 1, 1926. Its functions include studies and investigations and the gathering, compiling, analyzing, and publishing of statistical data relating to the economics of the mineral industries. The branch comprises a coal divi-

sion (including the Government fuel yards), a minerals and metals division, a petroleum economics division, and a division of mineral resources and statistics.

The health and safety branch, organized on July 15, 1926, investigates hazards affecting the health and safety of men engaged in mining, metallurgical, and allied industries, with the object of determining causes and devising methods of prevention.

The branch is divided into two divisions—the health and the safety. The work of the health division is chiefly investigative. The effects of changes in the physical condition and chemical constituents of the air and of insanitary surroundings are studied and recommendations made for improvement.

The major activity of the safety division is instruction in mine safety and accident-prevention and in mine-rescue and recovery work. The investigations include studies of the causes of accidents and the methods of prevention.

The chief of the administrative branch is the assistant to the director. The branch is composed of the office administration division and the information division. The office administration division, under the supervision of the chief clerk, is composed of accounts, personnel, clerical assignment, library, legal, multigraphing, mails and files, and property sections and handles the general routine business of the bureau. A board, headed by the chief clerk, recommends to the director all allocations, promotions, efficiency ratings, and other personnel changes. The information division, composed of the publications, reports, editorial, and graphic sections, handles all inquiries regarding the general work and publications of the bureau.

PERSONNEL

On June 30, 1927, there were 747 employees on duty in the bureau, 713 of whom held Secretary's appointments. They were distributed and classified as shown in the following table:

Number of employees on duty in the Bureau of Mines June 30, 1927

	Classification and number of appointees			
	Technical	Clerical	Nonclerical	Total
Washington	[1] 44	147	[2] 64	255
Pittsburgh	[3] 116	53	[4] 98	267
Field in general	[5] 120	42	[4] 29	191
Total	280	242	191	713

[1] Engineers 17, chemists 6, miscellaneous 21.
[2] Includes motor-truck drivers, mechanics, laborers, messengers.
[3] Engineers 41, chemists 35, miscellaneous 40.
[4] Includes firemen, mechanics, watchmen, foremen, and first-aid miners, instrument makers, messengers, janitors, etc.
[5] Engineers 44, chemists 28, miscellaneous 48.

Besides the employees enumerated in the table, there were 34 employees on field agreement, including cooks on mine-safety cars, making a total of 747, an increase of 29 employees and a decrease of

17 employment agreements as compared with the preceding fiscal year.

In addition to the 747 regular employees on June 30, 1927, there were 86 consultants and 31 other employees holding appointments at hourly or daily rates for intermittent service (a decrease of 60), or a total of 864, a decrease of 48, as compared with the total on duty at the close of June 30, 1926.

The total number of changes requiring the approval of the Secretary of Commerce, consisting of appointments, reinstatements, transfers, promotions, reductions, separations, extensions, etc., was 988. The number of changes in status on employment agreements issued by the director with the approval of the Secretary, including employments, separations, etc., was 628; a total of 1,616 in all—a decrease of 94 compared with the preceding fiscal year.

Of the employees on the roll on June 30, 1927, the following were appointed during the fiscal year: 75 technical (26 per cent of the 280 listed), 70 clerical (28 per cent of the 242 listed), and 103 nonclerical (53 per cent of the 191 listed), or an average of 34 per cent.

GENERAL ACTIVITIES

During the year the Bureau of Mines continued to strive to bring about safer and more healthful working conditions for the million men employed in the Nation's mines and quarries. As the winning of petroleum from underground is attended by considerable hazard, the bureau's safety activities were extended to cover it. Progress was made in the effort to extend to all bituminous-coal mines the practice of thorough rock dusting as a means of preventing or limiting mine explosions. The coal-mining industry is using an increasingly larger proportion of "permissible" explosives, and "permissible" mining machinery and equipment, approved by the bureau after thorough tests. As falls of roof cause nearly half of the accidental deaths in mines in the United States each year, the bureau is making a special investigation of this problem. In training miners in first-aid and mine-rescue methods, the bureau had the most successful year in its history. In all, 39,200 miners were so trained, bringing the total number trained by the bureau since its creation to 206,425.

In the field of metallurgy the bureau continued its efforts to conserve the Nation's mineral resources through the development and improvement of methods for recovering more of the mineral content of ores and lessening the cost of recovery. It is giving attention to the utilization of the low-grade manganiferous iron ores in northern Minnesota, in the hope of increasing the Nation's production of manganese, vital in the manufacture of steel and therefore of great military importance. Valuable fundamental data on the smelting of iron are being obtained through operation of the bureau's experimental blast furnace at Minneapolis, Minn., the only one of its kind in the world. Work is continuing on methods of utilizing the large reserves of low-grade, complex ores in the Western States and on the development of the flotation process, which has greatly increased the mineral wealth of the Nation. A method of agglomerating slime and fine particles in leaching ores, discovered by the bureau's engineers, is believed to hold promise of wide application to copper and other ores.

The Bureau of Mines is devoting much time to technical research on nonmetallic industries whose products enter into the construction of buildings and roads and thus affect virtually every community and every individual. In the search for potash deposits in the United States, work designed ultimately to relieve the American farmer from the domination by foreign interests of this essential fertilizer material, two test wells were completed in New Mexico, a third is being drilled, and a contract has been let for drilling a well in Texas. During the coming fiscal year drilling will be continued, probably for the greater part in Texas.

As it is estimated that no more than 20 to 25 per cent of the petroleum originally contained in underground deposits is obtained by ordinary methods, the bureau is studying methods to increase the recovery of oil from oil sands, a matter of vast economic moment. The experimental oil-shale plant near Rulison, Colo., was shut down June 30, 1927, because of the failure of the second deficiency bill, which contained an appropriation for the continued operation of the plant. Shale-oil produced during the operation of the plant was distributed for technical study, and two tank cars of it were sent to the League Island test plant of the Navy Department, the first movement of this kind in the history of American industry.

The bureau has continued to seek to increase efficiency in the use of fuels. A study of boiler-scale formation and boiler-water conditioning yielded fundamental data that make possible considerable savings in the Nation's fuel bill. Through changes recommended by the bureau, the cost of fuel at the power plant in the Capitol at Washington was reduced about $70,000 during the year.

Since the transfer to the Bureau of Mines of the division of mineral resources of the United States Geological Survey, and parts of the coal division and minerals division of the Bureau of Foreign and Domestic Commerce, the Bureau of Mines is giving more attention to the economic problems of the mineral industries.

SAFETY IN MINING

Rock dusting of coal mines.—The practice of rock dusting coal mines, to prevent or limit coal-dust explosions, has saved the lives of hundreds of American coal miners within the past two years; although it is not generally compulsory, its use is increasing in the United States. Partial rock dusting of mines, or rock dusting by improper or inadequate methods, however, provides no assurance of safety. Rock dusting may be worse than useless if it is not adequate and systematic. Merely perfunctory scattering of rock dust, or sporadic rock dusting at long intervals, or the rock dusting of only a few main haulage ways, may give an unwarranted sense of security. To provide assurance against deadly mine explosions, all accessible open areas, including entries, air courses, rooms, crosscuts, and pillar regions should be thoroughly rock dusted. The rock dust should be replenished from time to time, so that the incombustible content of the rib, roof, and floor dusts will always exceed 65 per cent.

The effectiveness of rock dusting in preventing disastrous explosions in bituminous coal mines has been demonstrated by the investigations and experiments of the bureau.

Recommendations of the American Engineering Standards Committee for standard practice in rock dusting have recently been published by the bureau as Information Circular 6030. Several members of the Bureau of Mines served on this committee.

Safe electrical equipment for mines.—One of the duties of the bureau is to study electrical mining equipment to ascertain whether it is likely to introduce a hazard. To assist the study of electrical apparatus certain safety standards have been developed. These standards, established with the aid of the manufacturer and the user, are published in schedules. Equipment that meets these standards is known as permissible equipment. This term means that the Bureau of Mines believes that the manufacturer has adhered to certain minimum standards of safety, thus rendering the equipment relatively safe for use in mines where flammable gas or coal dust may accumulate.

During the year 18 approvals of mining equipment and apparatus have been made; also 170 extensions of approvals have been issued.

The bureau's list of permissible electrical equipment covers practically every activity for which equipment is used in underground coal mining. Electric rock-dusting machines were added to the list during the year. Manufacturers are giving increasing attention to the designing of permissible mining machinery, and the bureau looks to the time when operators will be able to equip their mines efficiently with a complete line of equipment which has been tested and listed as permissible.

In addition to this approval work research has been undertaken to determine the ignition points of methane by various heated metals. The information obtained will be valuable in the approval work and will bear directly on the safety of mining equipment.

Safety rules for installing and using electrical equipment in coal mines, sponsored by the Bureau of Mines and the American Mining Congress, were published as Technical Paper 402.

Cooperative work with British Safety in Mines Research Board.—The cooperative arrangement between the United States Bureau of Mines and the British Safety in Mines Research Board, designed for the exchange of information, functioned most satisfactorily. Representatives of the Bureau of Mines were assigned to work in England, while representatives of the Safety in Mines Research Board were busy at the Pittsburgh Experiment Station. Investigations conducted during the year included the constitution of coal, the ignition of mine gases, and the extinction of flame by inert gas.

Work in the experimental mine.—At Bruceton, near Pittsburgh, the Bureau of Mines has the only coal mine in the world used exclusively for scientific experiments, including tests relating to mine explosions. During the year 100 coal-dust explosion tests were made in the mine, and 90 gas-explosion tests were made in a special steel gallery 1 foot in diameter by 100 feet long. The chief investigations were as follows:

(*a*) Tests of the explosibility of the dust of semianthracite coal from the Valley field of Virginia. These tests were requested by the Virginia State Mine Inspection Service and the operators. Because of their low content of volatile matter the dusts were explosive only when flammable gas was present.

(*b*) A systematic study of the operation of rock-dust barriers. The results and those of previous tests will permit publication of a list of barriers found most effective. Tests showed that the efficiency of a barrier varies with the type of the explosion reaching it, and consequently a barrier must be designed to meet the most severe conditions.

(*c*) Tests to determine the speed of uniform movement of flame through mixtures of natural gas and air in a 1-foot tube will be extended to determine the conditions under which gas explosions may stir up and ignite coal dust.

(*d*) A study of the igniting powers of various electric arcs showed that in laboratory work an arc may be preferable to the flame from black blasting powder as a source of ignition for coal dust.

(*e*) Tests of the strength of mine stoppings were made in cooperation with the Bureau of Standards, on whose grounds a testing chamber was built. Concrete slabs of different designs, representing mine stoppings, were fastened in one side of this chamber and tested to destruction by explosions of black blasting powder in the chamber.

(*f*) Tests in the experimental mine of the possible use of rock dust for extinguishing mine fires showed that a fire could be readily smothered when the dust could be thrown on with shovels. Gas fires, such as occur when gas from a borehole or an undercut is ignited, were readily extinguished with rock dust.

Falls of roof greatest cause of deaths in mines.—During 1925, the latest calendar year for which complete data are available, fatalities from all causes in and about the coal mines in the United States, which employed an average of 748,800 men, amounted to 2,234; fatalities from all causes in and about the metal mines of the country, which employed an average of 126,700 men, were 371. Nearly half of these accidental deaths result from falls of mine roof, yet although falls of roof kill far more men than any other class of accidents, they attract slight notice, because they lack the spectacular aspects of disastrous mine explosions. The killing of more than 1,200 coal and metal miners every year by falls of mine roof constitutes one of the biggest safety problems in the mining industry of the United States; its magnitude was recognized by Congress, which appropriated funds for a special investigation by the Bureau of Mines of the causes of these accidents and the possible remedial measures. The investigation involves the study of methods of mining as they affect roof action, methods of roof support, methods for testing the soundness of the roof, and State laws and local regulations as they affect the exercise of precautions. During the year work was confined largely to examination of coal mines, chiefly in West Virginia, where the cooperation of the State Department of Mines was obtained. In the course of the cooperative campaign in West Virginia, the number of fatalities from falls of roof was largely reduced in comparison with previous years, and the tonnage of coal produced was materially increased.

Coal-mine explosions.—All disastrous explosions in coal mines are investigated by engineers of the bureau, and supplementary tests or studies are often made at the experimental mine to aid in determining the probable cause, the means of propagation, and the factors that tend to retard the progress of an explosion. Conditions that

contribute to the liability of an explosion are also studied, with the cooperation of coal-mine operators, at mines where disasters have not occurred, and confidential reports containing recommendations for minimizing explosion hazards are transmitted to the operators.

Coal-mine fires.—The Bureau of Mines investigates all serious mine fires brought to its attention, seeking to determine their origin and the effectiveness of the methods employed in extinguishing them. The data obtained are used in publications on mine fires and as the basis for recommendations for minimizing fire hazards.

Flammation of coal dust.—Data on flammability of dust from different coals of different degrees of fineness are important in the study of dust explosions in mines. A laboratory apparatus in which dust explosions can be brought about with reproducible results and rapid changes of pressure recorded has been put in operation. A paper to be published in a technical journal describes the work of the last two years; a bureau report will describe the work of the last five years.

Sources of dust in coal mines.—Through an investigation covering 15 representative coal mines in six coal-mining States the bureau ascertained that dry undercutting is the most prolific source of coal dust in many coal mines. Dust from dry undercutting averaged 9,810,000,000 particles per cubic meter of the surrounding air; when water was applied to the cutter bar, only one-seventh as much dust from undercutting was in the air. This finding clearly shows the importance of using water in undercutting coal.

Permissible explosives.—A permissible explosive is an explosive that is similar in all respects to the sample which has passed certain tests prescribed by the Bureau of Mines and is used in accordance with the prescribed conditions. The number of permissible explosives on the active list—that is, those offered for sale by manufacturers—fluctuates, because as trade conditions change and new components are introduced, new compositions are offered and old ones are withdrawn. Consequently, lists of permissibles must be revised frequently. The last list is entitled "Permissible Explosives Approved Prior to June 30, 1927."

The conditions under which explosives are tested are also constantly studied in order that the requirements fixed will better insure the explosives meeting the conditions of practice. During the past year Schedule 17A, Procedure for Testing Explosives for Permissibility for Use in Coal Mines, and Schedule 1B, Procedure for Testing Explosives Used in Metal Mines, Tunnels, Quarries, and Other Engineering Operations, were issued.

Ethylene glycol dinitrate.—The most definite development in the explosives division of the bureau was the acceptance of ethylene dinitrate as a component of permissible explosives in part substitution of their content of nitroglycerin or in substitution of their content of nitrated polyglycerin. As glycerin is in demand for various purposes, its price and the cost of articles made from it have increased. Ethylene glycol dinitrate is made by nitrating ethylene glycol, precisely as glycerin is nitrated to produce nitroglycerin. As ethlyene glycol is synthesized from natural gas, an abundant supply for nitration is assured. Ethylene may also be obtained from coke-

oven and other manufactured gas and from the gases from cracked petroleum; moreover, it is easily made from grain alcohol. Explosives containing ethylene glycol dinitrate have passed the bureau tests for permissible explosives. Use of ethylene glycol frees the high-explosive industry from its dependence on glycerin and frees miners from the burden of high prices for explosives.

Sensitiveness of initiators.—A device, styled the pendulum-friction machine, devised by the Bureau of Mines, is now widely accepted as an efficient means for ascertaining the relative sensitiveness of blasting explosives to friction.

Initiators, such as mercuric fulminate, used in charging detonators for firing charges of blasting explosives, are sensitive to impact and friction. Because of their sensitiveness and shattering effect only minute quantities of initiators should be used in tests. By means of a pendulum-friction machine one-fourth the size of the standard, but similar in design, 23 different initiators have been tested and have been classified in six groups.

Poisonous gases from explosives.—Various poisonous gases, such as carbon monoxide, nitrogen oxides, and hydrogen sulphide, may be formed when explosives are burned or exploded; the quantities formed will vary according to the composition and character of the explosive and the conditions under which it is fired. When cartridges of explosives, particularly cartridges confined in a borehole, are fired, the paper and paraffin of the wrappers become components of the explosive and contribute to the gaseous products of explosion.

Tests show that confining an explosive reduces the proportion of carbon monoxide and hydrogen in the gases formed. If the charge is well confined, coal dust in the borehole does not appreciably increase the quantity of poisonous gas produced, but if the charge is insufficiently confined a blown-out shot results, which increases the production of poisonous and combustible gases and may initiate a mine explosion. More recently a comparison of the gaseous products of shots in mines and of tests of the same explosive in the laboratory has been undertaken. As actions for injury from the products of explosion are being instituted under compensation laws, precise information as to the kind and amount of these products is in demand.

Photographing explosives.—An explosion in a file of explosive or in an explosive mixture of air with dusts, vapors, or gases is a series of events occurring so rapidly that the eye can not distinguish them. Photography greatly extends the range over which the phenomena may be observed. Better knowledge of the successive changes should enable a purchaser to select an explosive for a given use, such as blasting in coal mines, with greater assurance.

The bureau has had constructed an apparatus consisting of a rotating drum (peripheral speed 20 meters per second) around which a sensitized film may be wrapped and a quartz lens, focusing through a stenopaic slit to the drum, all properly housed. With this apparatus, records of the propagation of detonation through a file of explosives have been made, a new method for measuring rate of detonation has been devised, and the propagation of detonation across an air gap between two cartridges of explosive studied. These

studies should lead to a more satisfactory method for ascertaining the sensitiveness of an explosive to explosion by influence than is provided by the "air-gap method" now in general use.

SAFETY INSTRUCTION

Training miners in safety methods.—Training in first-aid and mine-rescue methods was given in 581 mining, metallurgical, quarrying, or oil-producing communities in 40 States and Alaska to 39,200 miners; 206,425 in all have been trained since the establishment of the bureau. Moreover, several thousand city firemen, boy scouts, public-school children, and miscellaneous industrial workers have received training. The outstanding feature of the past year's work was the intensive training of a number of "key" men in mining organizations. These men then carried on campaigns for training 100 per cent of the employees; all thus trained were examined by bureau men before receiving Bureau of Mines certificates. In this way the mining communities have been given the burden of the first-aid training; the benefits have been numerous. This type of work has been carried on extensively in Illinois, Kentucky, and West Virginia, and to a less extent in other States. The bureau hopes to extend it to all mining communities.

Advanced training work.—In an attempt to convey to company officials the information that the Bureau of Mines engineers have acquired on the best methods of meeting conditions at mine fires and explosions, an advanced course has been given to 457 mine officials, State inspectors, and others. Nearly three weeks are required for this course, and it is difficult for mining companies to release officials for so long. It is to the credit of the companies that so many officials have been enabled to take the course.

Safety reports on mines.—Safety inspections of particular mines are frequently made by bureau engineers, and confidential written reports of the findings are sent to the operators. Generally, the recommendations are, at least in part, put into effect by the companies, with the result that neighboring mines ultimately adopt them. After a mine disaster, a confidential report with suitable recommendations is made by bureau engineers and a copy sent to the mine operator. Frequently the company complies with some or all of the recommendations. Especially has there been a tendency to adopt certain recommendations—such as those on closed lights and rock-dusting—after fires and explosions.

International first-aid and mine-rescue meet.—The fifth international first-aid and mine-rescue meet fostered by the Bureau of Mines was held in San Francisco, September 2, 3, and 4, 1926. A total of 44 first-aid and 14 mine-rescue teams were entered, representing 38 companies from 13 States and from coal and metal mines, quarries, and petroleum and metallurgical plants. These field meets are for the purpose of stimulating interest in first-aid and mine-rescue activities and in general safety.

Holmes Safety Association.—During the year 8 new chapters of the Holmes Safety Association were organized—4 in Kentucky, 2 in Pennsylvania, 1 in Washington, and 1 in Illinois. In all, 175 chapters have been organized throughout the United States. Their pur-

pose is to promote the health, safety, and welfare of miners and their families.

National safety competition.—More than 250 mines and quarries in 30 States participated in the national safety competition in 1926. The winners of this contest, held annually under the auspices of the Bureau of Mines, are presented with the bronze trophy "Sentinels of Safety."

HEALTH, SANITATION, AND VENTILATION

Ventilation of metal mines.—In many metal mines the health of the worker is menaced by harmful dust and poor ventilation which also react on his comfort and efficiency. For some years the bureau has been studying temperatures, humidity, air movement, and quality of air in various mines, to obtain facts for the betterment of working conditions.

Natural ventilation is important in deep mines, yet little is known about it except in theory. Investigations are in progress to determine the effect of natural draft on the operation of mine fans. During the past year data previously obtained in a small mine having natural ventilation only were augmented by observations to determine the theory of the action of natural draft in multiple-level as distinguished from single-level mines.

As the theory of the operation of mine fans, particularly when arranged in series, was not definitely established by experiment, a large number of tests of four small fans such as are used for auxiliary ventilation in mines were made. These tests showed that fan performance is the same whether the duty is all on the blowing side, all on the suction side, or distributed between the two; that the performance of fans in series can be ascertained from their separate performances measured on a total-pressure basis, but not on a static-pressure basis, as given in present textbooks; and that fan efficiency is practically independent of speed.

Tests were made in the Moffat railroad tunnel, Colorado, to determine ventilating-current resistances. The results were not only applicable directly to the ventilation of the tunnel, but furnished information on the effect of area, spacing of timber supports, and low-velocity flow in metal-mine airways.

A study of the extent, character, and quality of irrespirable gas in mines at Cripple Creek, Colo., was completed.

Causes of death among miners.—Bureau of Mines surgeons continued a study of the causes of death among miners. Data have been compiled from the records of the States of Nevada, California, Arizona, Colorado, Wyoming, Alabama, and Utah. The purpose of the study, which will cover all mining districts in the United States, is to ascertain the commoner diseases and types of accidents in order to prevent them.

Acid coal-mine drainage.—A study of drainage from a number of coal mines on two small watersheds in Pennsylvania has indicated that the amount of acid in mine drainage differs in different localities, at different mines in the same locality, and in different sections of the same mine. To ascertain the reason, the coal and the strata above and below the coal are being sampled and analyzed.

Another phase of the study is the sealing of abandoned mines. Abandoned or worked-out mines, particularly if not caved, give off highly acid water for many years, but at several places natural caving or artificial sealing has so improved the quality of the outflowing water that the water is used for domestic supply. Sealing apparently excludes air and consequently prevents, partly or almost wholly, the oxidation of pyrite and formation of acid. Arrangements have been made with several operators to seal recently worked-out or old, abandoned mines by shooting down the entries or by erecting concrete bulkheads. The acidity of the drainage from these mines will be determined at intervals before sealing and over a period of years after sealing.

Examination of rock-dusting material.—Use of inert dusts to prevent dust explosions in coal mines may induce silicosis or miners' phthisis, unless care is taken to exclude certain types of dusts. The bureau has given attention to various rapid tests for determining the suitability or unsuitability of a dust. Intraperitoneal injections of fine dusts have been made in guinea pigs which, after a time, have been examined for adhesions. In certain cases the results have been correlated with those obtained by exposing animals to dusty atmospheres. Hence, intraperitoneal injections have value as a more rapid test than the inhalation method.

Effects of breathing pure oxygen.—A study was undertaken to determine how long a high-oxygen atmosphere could be breathed day after day with no deleterious effect—a point to be considered in connection with the use of self-contained oxygen breathing apparatus and the administering of oxygen in the treatment of carbon monoxide poisoning. Experiments show that small animals may inhale 95 per cent oxygen for 16 hours a day for 50 consecutive days with no obvious ill effects, but inhalation 24 hours a day causes severe lung irritation and death in 2 to 4 days.

Study of poisonous petroleum vapors.—Hydrogen sulphide in petroleum vapors in certain Texas oil fields constitutes a serious hazard which necessitates constant precautions. During the year the bureau investigated conditions in the Panhandle field, in the Big Lake field of Reagan County, and in the McCamey field of Upton County. Recommendations to bring about safer conditions are given in Serial 2776, Hydrogen Sulphide Poisoning in the Texas Panhandle.

Carbon monoxide studies.—To determine the effect of repeated daily exposure for five to seven hours to low concentrations of carbon monoxide, such as might prevail in tunnels, garages, and occasionally in mines, a group of six men are being exposed seven days a week and carefully observed for symptoms of poisoning and psychological effects.

The purpose of another investigation is to ascertain why some cases of poisoning have serious sequelæ, while in others, after similar exposure, recovery is rapid and apparently complete. It is hoped that the information will serve as a basis for a better method of treatment of carbon monoxide poisoning.

The carbon monoxide recorder designed by the Bureau of Mines has been adopted for use in the Holland tunnels, New York City, and approximately 30 will be installed there. This device records on a time chart the carbon monoxide content of the air, and is

sensitive to about 0.02 per 10,000 (2 parts per 1,000,000). A bell rings when the carbon monoxide reaches a concentration of 4 parts per 10,000 or more.

Ventilation conditions in the garage of the Government fuel yards, Washington, D. C., and in a commercial garage in Pittsburgh, Pa., were studied, and changes in the ventilation system were made in order to reduce the proportion of carbon monoxide in the air the workers breathed. A summary of the results of these studies is being prepared.

Lead poisoning from ethyl gasoline.—The investigation of ethyl gasoline has been completed and the results published. The results indicate (1) the products of combustion from an engine using ethyl gasoline are apparently safe when diluted enough not to produce carbon monoxide poisoning; (2) the exhaust gases of an engine burning gasoline containing five times the commercial amount of ethyl fluid, if diluted enough not to produce carbon monoxide poisoning, are a potential hazard, as a small accumulation of lead was found in the tissues of animals exposed thereto; (3) daily inhalation of 1 per cent of ethyl gasoline vapor for one hour a day is apparently noninjurious; and (4) applications of 1 cubic centimeter per day on the skin of small animals is noninjurious if no vapors are inhaled.

Development of respirators.—In cooperation with the National Safety Council the protection afforded spray painters against lead, benzol, and silica sprays by various commercial forms of masks and respirators was investigated. Silica is sometimes used in vitreous enamels for spray-coating bathtubs and similar enameled-metal sanitary ware.

Most types of respirators with filters restrained more than 90 per cent of the lead in paint spray. Only those with activated-charcoal or similar adsorbents were effective in restraining benzol vapors. The respirators were much less effective against silica-dust sprays.

Many industrial dust respirators, fabrics, and filtering materials were tested for filtering efficiency. A new type of respirator, which has a filtering efficiency equal to that of the gas mask but is lighter and more convenient to wear, is described in Technical Paper 394, Dust Respirators: Their Construction and Filtering Efficiency.

Study of gas masks.—During the year attention was given to the hose mask, a device that has a face piece connected to a long flexible hose that extends to pure air. This device is useful when poisonous atmospheres not too remote from pure air are encountered in tanks, sewers, etc. With the present devices 150 feet is considered the maximum length of hose. As a result of its study the bureau issued Schedule 19, Procedure for Testing Hose Masks for Permissibility, and will undertake to issue approvals for hose masks that are submitted in accordance with the provisions of the schedule and pass the tests specified.

The study of gas masks for use in mines and of self-rescuers—small respirators that protect a miner from carbon monoxide for one-half hour and thus may enable him to escape from a fire or after an explosion—was continued. Carbon monoxide gas masks similar to those first devised in the Bureau of Mines are now made commercially and are standard equipment for mine-rescue and recovery operations. Lives of some miners were saved during the year by use of self-rescuers.

Toxic effects of alkyl halides used as refrigerants.—Because of possible leakage the toxicity of alkyl halides used as refrigerants is important in industrial and domestic refrigeration and will be in mining if refrigeration for conditioning air in hot mines should prove practicable. The relative toxicity of methyl chloride, methyl bromide, ethyl chloride, and ethyl bromide on guinea pigs has been determined cooperatively with the National Research Council and a chemical manufacturing company. Ranked according to increasing toxicity, the four compounds are ethyl chloride, ethyl bromide, methyl chloride, and methyl bromide. A report is being prepared.

Warning agents for manufactured gas.—Experiments were conducted to determine the intensity of the odors and the lacrimatory and irritant powers, at various concentrations, of chemicals that might be added to manufactured gas to warn people, either awake or asleep, of its escape. So far the results indicate that stenches are not of great value in awakening sleeping persons; substances that irritate the eyes or cause sneezing are more effective.

Synthetic atmospheres in caisson disease.—In cooperation with the Navy Department, work was continued on the use of helium in diving and caisson operations and in the treatment of caisson disease. Experiments with animals were conducted to determine the optimum decompression at various pressures for different periods.

Physical examination of miners.—During the year the bureau entered into an agreement with the Metropolitan Life Insurance Co. and the Tri-State Zinc Ore Producers Association for the purpose of expanding the clinic already in operation by the bureau at Picher, Okla., to afford facilities for examining each workman in the district at least once a year to determine the effects, if any, of working conditions on the health of miners. During the year 2,533 examinations of men and 219 of women were made and 287 men were reexamined—a total of 3,039 examinations.

Lead poisoning in mining of lead ores.—A survey of lead poisoning in the lead-mining industry of Utah, made at the request of operators and miners, covered two years; it indicated lead-poisoning rates of 0.83 and 0.50 per 1,000, for the respective years, for the entire population of the State. Results of the survey are given in Technical Paper 389, Lead Poisoning in the Mining of Lead in Utah.

EFFICIENCY IN MINING

Blasting methods in coal mines.—Blasting methods at typical mines working in different coal beds have been studied to determine the factors involved in producing the maximum amount of lump coal, particularly if permissible explosives are used. It is planned to publish the essential facts collected.

Storage-battery and wired distribution of power.—Use of storage batteries instead of fixed wiring in coal mines reduces the explosion hazard and practically eliminates the shock hazard. A study was undertaken to determine the conditions under which storage batteries may compete in cost and efficiency with other means of supplying electric energy. During the year coal-cutting, hauling, pumping, air-compressing, and rock-dusting machinery at three "wireless" mines in southern West Virginia was studied. Comparable data will be obtained from the Pittsburgh and northern West Virginia districts.

Preservation of mine roofs.—The different methods used in coal mines to prevent disintegration of shale or clay roof by atmospheric action were investigated. Mines that have used "guniting," "mudding," high-pressure rock-dusting, and other methods of protecting the roof were visited. The data obtained, including costs, will be prepared for publication.

Coal-mining methods in Alabama.—Studies of the mining of coal at the face were continued throughout the year. The data obtained are being assembled for publication.

Insuring the mine-timber supply.—The bureau is obtaining data on mine timber treated with various preservatives. Although the facts gathered relate largely to coal mining, some data obtained from western copper mines will be included in the report being prepared for publication.

Subsidence of land after coal mining.—A detailed study of surface subsidence from coal mining in the State of Illinois has been conducted in cooperation with the State Geological Survey and the engineering experiment station of the University of Illinois. Details are given in Bulletin 238, Subsidence Due to Coal Mining in Illinois. The study of ground movement in connection with coal mining and pillar extraction at a Wyoming mine is being continued.

Ground movement and subsidence in metal mines.—To support inclosing formations and overlying rock masses at great depths requires modifications of methods previously found adequate, and the application of such data as can be obtained on the occurrence of lines of weakness and the manner of failure of formations, distribution of stresses, and the like. These factors are being investigated in order to assist operators in safeguarding their mines and adjacent properties against possible damage.

Mining Alabama iron ores.—The rapid development of iron-ore mining in the Birmingham (Ala.) district has been made possible by investigations that have led to radical changes in furnace practice. Should beneficiation make available the high-silica ores of the lower bench of the Big Seam, the most important ore bed, mining practice must necessarily be modified and mining will become more difficult as the weight of cover increases with depth. Bulletin 239, Iron-Ore (Hematite) Mining Practice in the Birmingham District, Alabama, recently issued, suggests improved mining practices that may be necessary.

Blasting methods in metal mines.—In cooperation with mining companies of the Southwest, the bureau is endeavoring to ascertain the safest and most economical explosives to use in metal mines and the best methods of blasting under various conditions. Results of a study of drilling and blasting drift rounds are discussed in Serial 2789, Charging Explosives in Drill Holes of Drift-Rounds in Metal Mines.

That the cost of mining in hard-ore stopes in metal mines can be decreased appreciably by proper blasting methods and care in the selection of explosives was demonstrated by experiments in certain Arizona copper mines. Results are given in Technical Paper 383, Blasting to Lessen Bowlders in Hard-Ore Stopes.

METALLURGICAL INVESTIGATIONS

FERROUS METALLURGY

Experimental blast furnace.—From time to time the cooperation of the Bureau of Mines is solicited in connection with problems involving the use of new or untried raw materials in the iron blast furnace. In some cases laboratory experiments yield information for determining the feasibility of proposed innovations; in others, however, a practical small-scale test is the most satisfactory means of obtaining information to guide full-scale operations or to determine their feasibility. For conducting such tests the bureau developed at the North Central Experiment Station, Minneapolis, Minn., an experimental iron blast furnace, the only one of its kind in the world.

During a two-week test the furnace ran on a charge of ferruginous bauxite, iron ore, turnings, and limestone. About 70 tons of slag, composed largely of calcium aluminate, 6 to 10 per cent of silica, and about three times the normal percentage of alumina, was produced without difficulty. Information was obtained concerning the effect of the composition of slag on blast-furnace practice and the utilization of low-grade bauxite in the production of aluminum and high-alumina cements.

Utilization of manganiferous iron ores.—Experimental work conducted by the bureau in cooperation with the Minnesota School of Mines, on the possible utilization of the low-grade manganiferous iron ores in northern Minnesota, gives some promise of the development of metallurgical processes which may make these ores available for the iron and steel industry. About 150 tons of high-phosphorus spiegel has been produced from manganiferous iron ore in the 6-ton experimental blast furnace, and some of it has been melted in an experimental open hearth, where the manganese is recovered in a slag containing 40 to 50 per cent of manganese and suitable amounts of phosphorus and iron. Some progress was made in treating high-phosphorus spiegel in a cupola and a basic converter to produce a high-manganese slag or synthetic ore for making ferromanganese.

Fundamental reactions in the iron blast furnace.—Certain work with the experimental blast furnace at Minneapolis indicated that the flow of gas and stock in the shaft was uneven, and in consequence the composition, temperature, and pressure of the gas in the shaft were irregular across any plane parallel to the hearth plane. Some light was thrown on conditions in the shaft of the experimental furnace by gas samples taken across a series of planes, at various elevations, parallel to the hearth plane. Later a series of gas samples and temperature and pressure readings was taken at a 300-ton southern furnace. Another series of observations at a modern 700-ton furnace running on northern ores has been completed. In this investigation a water-cooled Pitot tube was developed for measuring the flow of gas through beds of broken solids. The data obtained, which embrace the composition, temperature, pressure, and velocity of the gas across four planes, afford an insight into the reactions taking place in the furnace.

Calculations indicate that the concentration of alkali cyanides in the blast furnace would not be greatly lowered by withdrawing a part of the gas for the recovery of cyanides, and it seems unlikely that furnace operation would be adversely affected. The amount of cyanides recoverable in this way would be commercially significant. If one-tenth of the gas at a certain plane in the furnace studied by the Bureau of Mines investigators were withdrawn, it is estimated that the daily recovery of crude cyanide would be 1,040 pounds, worth, at 10 cents a pound, $104.

Desulphurizing pig iron by blast-furnace slags.—The importance of desulphurizing pig iron and the limitations which sulphur specifications place upon blast-furnace fuel encouraged the bureau to seek to ascertain, at its North Central Experiment Station, Minneapolis, the mechanism by which the sulphur incorporated in the metal above the tuyères is removed in the crucible, and whether slag removes the major part of the sulphur as the globules of iron drop through the slag bath or after the two liquids have collected in the crucible. Preliminary tests show that the sulphur in molten pig iron can be reduced from 0.08 to 0.01 per cent by dropping small globules of the iron through a 10-inch layer of certain types of slag held at 1,500° to 1,525° C.

Gas-solid reactions in the blast-furnace shaft.—Efficient operation of an iron blast furnace requires that the raw materials charged be properly prepared in the shaft for the finishing reactions in the hearth. Reduction of the ore, calcination of the stone, and preheating of the entire charge in the shaft depend upon the opportunity for contact between gas and solid. Gas generated at the tuyère level carries heat to the materials in the shaft and also reduces the iron oxide.

Observations at two industrial furnaces and at the bureau's experimental furnace show that in modern furnaces the distribution of gas is not uniform. To improve that distribution it is necessary to have information on the resistance offered by beds of aggregates of various sizes. The investigation may be divided into three interrelated problems: (1) Flow of gases through beds of broken solids, (2) heat transfer from a moving gas stream to a bed of broken solids, and (3) mechanism and rates of reduction of iron oxides by gases comparable to those in the blast furnace. Work on the first problem will soon be completed; work on the others includes preliminary tests.

Physical chemistry of steel making.—Fundamental information on the reactions in the manufacture of steel will lead to better understanding of many factors which affect production and quality, and will also lead to improvement of present-day practice. The physical chemistry of steel making has been studied for one year. The problems under investigation are (1) the solubility of iron oxide in iron and the effect of iron oxide on the physical properties of pure iron, (2) the effect of composition of slag on the solubility of iron oxide in iron, (3) the formation and identification of nonmetallic inclusions, and (4) the viscosity of slags. This problem is being studied by Carnegie Institute of Technology and its metallurgical advisory board in cooperation with the Bureau of Mines.

Research on production of sponge iron.—The development of a small iron and steel industry in certain western localities is suggested by experiments on the production of sponge iron at the North-

west Experiment Station, Seattle, Wash. Sponge iron also promises to be increasingly important in the hydrometallurgy of low-grade copper ores and complex lead ores.

Sponge iron precipitates copper, lead, and other metals from solution. It is conceivable that the success of some large-scale leaching and precipitating processes for copper and lead ores may depend largely upon a supply of cheap sponge iron.

The investigations undertaken by the Bureau of Mines have, it is believed, yielded information that should aid the design and operation of furnaces for producing sponge iron economically. Details are contained in Bulletin 270, Production of Sponge Iron, recently published.

Saving the iron that goes up the stack.—About 75,000 tons of iron is lost yearly as flue dust escaping from blast furnaces in one district in the South. The flue-dust losses in that district average 250 pounds per ton of pig iron produced. On the basis of the present rate of pig-iron production the annual loss of flue dust exceeds 300,000 tons. As the iron content of the dust probably averages 25 per cent the loss of iron amounts to about 3 per cent of the iron mined in the district. By the use of magnetic concentrators of various kinds it is thought that much of this loss can be prevented. Details of an investigation made by the Bureau of Mines are given in Serial 2761, Magnetic Concentration of Flue Dust of the Birmingham District, Alabama, recently issued.

Concentration of Wyoming iron ores.—In a cooperative study of the concentration of Wyoming iron ores the bureau sought to learn the physical properties of the ore as shown by float-and-sink tests with heavy liquids. After the fundamental properties of the ore were determined the cooperating company continued the investigation by transferring the problem to a commercial ore-testing laboratory. Heavy liquids proved to be of great assistance in forecasting the kind of mill products to be expected.

Case carburizing of steels.—A study of the carburizing quality of steels, made in a small electric furnace where conditions could be held constant, has shown that there is a direct relationship between abnormality of steel and the carbon and manganese content. The relationship found does not, however, apply quantitatively to commercial practice, as other variables have to be considered. The rate of solidification and cooling has a marked effect on the abnormality. The study is being continued.

NONFERROUS METALLURGY

Improvement in leaching methods.—A method for agglomerating slime and fine particles in leaching ores, discovered through experiments at the Southwest Experiment Station, Tucson, Ariz., is considered to hold promise of wide application in the metallurgy of copper and other ores. Enormous tonnages of tailings carrying from 0.2 to nearly 1 per cent of copper, have accumulated at copper concentrators. At many places the copper in these tailings is amenable to leaching, but leaching by present methods is too costly. Under the newly discovered method the slime and fine particles can be agglomerated and agglomeration so maintained that masses of ore containing finely divided material can be made permeable

to downward-trickling leaching solutions, provided open drainage is maintained at the bottom and the solutions are not allowed to pool on the surface. Should agglomeration prove practical much of the copper now in tailings piles might be recovered. Not only may finely divided material be leached by this method, but clear effluent liquors may be obtained without filtering.

Sponge iron as a precipitant of lead and copper.—The relationships of the various common constituents of leaching solutions when lead is precipitated from brine solutions and copper from sulphate solutions were determined experimentally at the Intermountain Experiment Station, Salt Lake City, Utah. An apparatus was developed in which sponge iron might be used. This apparatus utilizes nearly all the iron in the precipitation of the metals and requires little labor. The Bureau of Mines had previously developed a method for producing sponge iron.

Treatment of copper-smelter flue dust.—At many copper-smelting plants the heavy circulating load of dust overburdens the settling capacity and causes losses; improved methods for treating flue dust would consequently be of benefit. The bureau has made mineralogical analyses of the copper minerals in the flue dusts of southwestern smelters and has found that where the content of precious metals was not too high and the copper in the original ore was oxidized or was mostly chalcocite the dust could be leached successfully.

Form of copper in converter slags.—The molten converter slag usually added in reverberatory practice has been considered responsible for much of the loss of copper in reverberatory slags. Study of converter slags has shown that the copper is present mainly as sulphide. It was found that the silver nitrate method often used to distinguish "pellet" from "dissolved" copper sulphide, and thereby give a criterion as to the efficacy of settling, would have to be carefully standardized as to fineness of grinding the sample as well as regulation of solution. The investigation showed the importance in converter operation of considering temperature, as well as the physical and commercial nature of the converter slags.

Manufacture of ferric sulphate and sulphuric acid from roaster gas and ferrous sulphate solutions.—One of the main problems studied at the Southwest Experiment Station has been the development of a cheap solvent for leaching semioxidized copper ores. A new method of making ferric sulphate-sulphuric acid solutions from waste roaster gases has been discovered, and during the year a semicommercial plant has been successfully operated in cooperation with a mining company. This method of acid making is also being used at one plant on a semicommercial scale, at a second plant on a pilot-plant scale, and at a third on a laboratory scale.

Study of pyritic copper ores.—Microscopic study of the pyritic copper ores of the Southwest has been completed; it shows that the copper minerals may be separated from the intimately associated pyrite by extremely fine grinding, but there is some question as to whether the cost of such grinding of the entire mill feed would be justified. However, to apply the facts obtained by microscopic study of fineness of grinding to the treatment of a bulk concentrate may be feasible; the amount of material handled would be relatively small, and the crushing cost correspondingly low.

Smelter research problems.—The advisory committee on smelting, comprising leading operators and consultants of the Southwest, has strongly advised continuation of the present smelter program at the Southwest Experiment Station of the Bureau of Mines. A committee on the copper reverberatory, appointed by the American Institute of Mining and Metallurgical Engineers from among the same group, is also acting in conjunction with the metallurgists of the bureau. A general exchange of information on the operation of the reverberatory should result.

Manufacture of aluminum from clay.—The United States is one of the largest producers and one of the largest potential producers of aluminum and pure aluminum compounds. The Nation, however, depends to an increasing extent on imported bauxite for raw material to be used in the manufacture of alumina and aluminum hydrate for those industries. Studies for the development of acid extraction processes, leading to cheaper methods for obtaining aluminum metal from clays and other aluminum silicates abundant in nature, have been completed by the bureau. Many power sites in the western intermountain region could produce aluminum cheaply if a satisfactory source of aluminum oxide were available. Details of this investigation are given in Bulletin 267, Acid Processes for the Extraction of Alumina, published during the year.

Milling problems in Tri-State zinc district.—From year to year, the zinc ores of the Tri-State district of Oklahoma, Kansas, and Missouri are becoming leaner and more complex. This condition demands improvements in milling. Higher recoveries would be reflected in increased reserves of ore. Work by the bureau has been in progress since the beginning of the fiscal year 1922, but during the past year only a small amount of time was given to it pending the building of tailing mills in accordance with plans already developed. These mills are now under way, and the work will be resumed. The earlier work was in the mills treating the virgin ores. The next work will be on improvements in the tailing mills.

Milling of southeast Missouri lead ores.—Operators of the southeast Missouri lead district employ good milling practice but are making improvements because the mill feed is becoming leaner. Development of zinc ores in some mines and copper ores in others will be a compensating factor when a better recovery of the lead, zinc, and copper is assured. Only a small recovery of the zinc has been realized, and work on the copper problem has hardly begun. The bureau has taken up the work as a district problem and has identified those mill products which need special attention. The operators are using the laboratories at the Mississippi Valley Experiment Station, Rolla, Mo., to make test runs.

Electrothermic metallurgy of zinc.—In the hope that zinc ores may be smelted more efficiently and more cheaply and complex ores not workable at a profit by present processes may some time be treated economically, the bureau studied the electrothermic distillation of zinc. During 1926, in cooperation with the Missouri School of Mines and Metallurgy, an experimental electrothermic distillation plant having a daily capacity of several hundred pounds of zinc was completed. Operation a number of times yielded valuable data, but the electrical transformers proved insufficient for operating the plant at

full capacity. As funds were not available to provide equipment for demonstration runs, virtually no work could be done during the past year.

Condensation of zinc.—Though the condensation of zinc has been studied by research workers, fundamental knowledge of many phases of the problem is still lacking. In retort smelting some blue powder is always formed. The numerous proposed or partly developed processes of electric smelting have encountered difficulty in satisfactorily condensing the zinc vapor to liquid metal. An investigation in progress has largely dealt with attempts to obtain accurate samples of atmospheres produced in zinc smelting.

Flow of heat through zinc-retort walls.—In present retort smelting of zinc ores in the United States better knowledge of heat requirements would aid more economical operation. More exact data on the heat necessary to bring the retort and charge up to smelting temperatures and maintain them there might lead to shorter time of distillation and less consumption of fuel. In order to get accurate information on heat requirements, the bureau has designed an electric retort furnace. Valuable data have been obtained concerning its capacity, rate of heating, and heat losses.

Pyrometallurgy of lead.—That prevailing lead-smelting practice entails loss of lead in slags is well recognized. A method for determining metallic lead has been worked out at the Intermountain Experiment Station, and its application to the problem of losses in slag is of considerable importance. Many factors contribute to these losses. By applying a combination of chemical, microchemical, and microscopic methods the bureau hopes to gather valuable data on the physical form in which the losses occur.

Reduction of zinc oxide.—Studies of the reduction of zinc oxide at the Pacific Experiment Station, Berkeley, Calif., were completed. They have afforded a fairly precise determination of the free energy and specific heat of zinc oxide. Three papers outlining the more abstruse phases of the work were given to the technical press. Exact determinations were made of the conditions necessary for large-scale gaseous reduction of zinc oxide with better economies than those of the present distillation method.

Specific heats of common metal oxides.—At the Pacific Experiment Station determinations of the specific heats, between room temperature and liquid-air temperature, of the oxides of lead, iron, copper, tin, and manganese have been virtually completed. These determinations and high-temperature determinations not yet undertaken will be used in connection with a study of the reduction of the oxides and sulphides of the more important metals.

Flotation of lead and zinc gangue materials.—At the Intermountain Experiment Station research on the minerals of lead and zinc has established important facts in regard to the action of certain reagents used in flotation. The presence of certain minerals in the gangue was found to be important; in some instances these minerals modified the action of reagents that had decided effects on the pure sulphide minerals alone. Hence it is desirable to study the flotability of the several gangue minerals individually and mixed with others. The results obtained will be correlated with the data already available on the flotability of the oxide minerals. Microscopic examina-

tion indicates that plumbojarosite in many of the lead ores is largely responsible for a material part of the loss of lead in flotation.

Flotation of tungsten ores.—Data obtained during the study of the fundamentals of flotation suggest the possibility of treating tungsten ores by flotation; its application depends largely upon the success of work now being done on nonmetallic and oxide minerals.

Investigation of crushing and grinding.—The efforts of the Intermountain Experiment Station to determine the amount of work done in crushing ores have yielded results, and a series of crushing tests has established the validity of the Rittenger law. Surface measurement of sized quartz particles shows that internal fractures or cracks greatly increase the surface of the crushed particles. The larger the particle the more these cracks increase surface as measured by the dissolution method.

Surface determinations of minus 200-mesh ground quartz show that the average size of this product is much less than the usually accepted figure—37 microns. Such determinations also show that the amount of surface produced by crushing to minus 100 mesh varies greatly, and this variation is an index of the "useless work" done in crushing.

Surface measurements of quartz ground in rod mills showed that increasing the number of rods, or the time during which a charge remains in the mill, increases the fineness of the minus 200-mesh material. Experiments with several different varieties of quartz, including crystalline, "bull" quartz, and vein quartz, showed that the rate of dissolution in hydrofluoric acid (a method of measuring surface) was the same in all tests. A report on the completed work on quartz has been prepared for publication.

Cyanide recovery of gold and silver associated with arsenic and antimony.—In present milling practice those ores in which arsenic and antimony minerals are closely associated with gold and silver are considered typical refractory ores. A study of the cyanide recovery of precious metals in each arsenic or antimony mineral has been completed at the Rare and Precious Metals Experiment Station, Reno, Nev., and a process indicating maximum recovery for each mineral has been outlined.

Precipitation on charcoal of gold and silver from cyanide solution.—A study of the precipitation from cyanide solution of precious metals on charcoal has been made by the Rare and Precious Metals Experiment Station. The purpose of the study was to investigate the possibilities in practice and secondarily to investigate the mechanism of the precipitation itself. Details are given in Technical Paper 378, Precipitation of Gold and Silver from Cyanide Solution on Charcoal.

Recovery of titanium minerals from bauxite sludges.—The demand for titanium oxide for paints prompted the bureau to study the recovery of titanium materials from bauxite sludges. For many years the tailing from a large aluminum oxide plant in the Middle West has been known to contain titanium. Work on possible methods of recovering titanium minerals from the tailing is in progress at Rolla, Mo. Products containing as high as 46 per cent of titanium oxide have been made in the laboratory from material otherwise waste.

Hydraulic classification of ores.—At the bureau's Moscow (Idaho) field office a study of hydraulic classification has been continued. The first work, on what is called hindered-settling classification, is described in Technical Paper 403, Hydraulic Classification. The scope of the study now embraces the general subject of stratification. Results have pointed the way to better classification, and some promising practical developments are under way.

Thermodynamic properties of oxygen and nitrogen.—In connection with the program for obtaining cheaply industrial oxygen gas for metallurgical and other operations, the Pacific Experiment Station prepared tables and charts giving the thermodynamic properties of oxygen and nitrogen. These tables correspond to steam tables used by power-plant engineers and ammonia tables used by refrigeration engineers. They give the mutual relations of temperature, pressure, heat content, entropy, and other thermal properties of the two gases and include a Mollier chart for each. The report will probably be published during 1928.

NONMETALLIC MINERALS

Elimination of waste in slate quarrying.—The waste in slate quarrying, which reaches 70 to 90 per cent of gross production, induced the bureau, through its Nonmetallic Minerals Experiment Station, New Brunswick, N. J., to attempt to work out better processes for making primary cuts in quarries. Wire-saw equipment was purchased in cooperation with five slate companies, and cuts were made under the bureau's direction. The results indicate the wire will cut about twice as fast as present equipment, that there is no shattering of slate, and that the cost of operation is less than half that of the channeling machine now used. Further testing will be done.

The results of a survey of interesting developments of the past few years in the slate industry are described in Serial 2766, Recent Progress in Slate Technology, recently issued.

Prevention of mica wastes.—Recovery of highly valuable mica wastes, hitherto lost in the ground-mica industry because of incomplete settling in the wet grinding process, is promised as the result of experiments at the Nonmetallic Minerals Experiment Station with electrolytes as flocculating agents. As finely ground mica attains a value of $100 to $120 per ton, the losses reach proportions that seem to demand a remedy.

Because of the increasing interest in mica, particularly for radio and electrical equipment, the bureau made a survey of the industry and studied problems of production and utilization. Visits were made to the more productive centers in New Hampshire and North Carolina and also to scattered operations in the Southern and Western States. Much attention has been given to specifications and the uses of mica.

Limestone for metallurgical purposes.—Approximately 23,000,000 tons of limestone are annually used for metallurgical purposes in the United States, chiefly as flux in the iron blast furnace.

Many limestone producers know little about the use of the stone in metallurgy. On the other hand, the metallurgist's knowledge of conditions governing the production of limestone is commonly small. The results of a study made to coordinate the problems of the

limestone producer and the metallurgist have been published by the bureau in Information Circular 6041.

New method of burning lime.—The Nonmetallic Minerals Experiment Station has made exhaustive tests with a sintering machine such as is used for roasting sulphide ores. The advantages claimed for this machine are low first cost, low maintenance cost, fair fuel ratio, continuous operation, and ability to use small stone. The results obtained indicate that the machine has excellent possibilities, but considerable redesigning is necessary. A description of the machine and the experiments conducted with it are given in Serial 2762, Manufacture of Lime from Small Stone With a Sintering Machine, issued during the year.

Effect of steam on calcination of limestone.—A long series of laboratory tests was conducted at the Nonmetallic Minerals Experiment Station to determine the effect of steam on the calcination of limestone. Tests showed that the chemical or catalytic effect was negligible, but the use of steam was decidedly advantageous in lengthening the flame and equalizing the temperature throughout the kiln, thus increasing efficiency and preventing overburning of the lime. Carbon dioxide has practically the same effect as steam.

Anhydrite as a cement retarder.—In answer to an urgent demand from the industry for information on the effect of the fineness of anhydrite used as a retarder in cement and the effect of retarders, the bureau has undertaken further work to determine these effects, using exact methods and special equipment.

Milling of fluorspar in Illinois and Kentucky.—An investigation of fluorspar milling, undertaken to reduce the loss of spar in the tailing and to improve the grade of the concentrate, has been pursued at intervals for two years. During that time operators have put the principles of closer sizing into effect, have adopted classification of table-feeds, and have realized improvements. One company abandoned unsatisfactory tables and installed a complete classifying and tabling plant. The low density of fluorspar (specific gravity, 3.15) makes treatment by gravity concentration a most difficult problem. Study of the problem has led to new ideas on gravity concentration; they will be presented in a paper now being written. In the laboratory acid spar has been recovered from materials formerly regarded as waste; the product made analyzed 0.4 per cent of SiO_2, 0.6 per cent of $CaCO_3$, and 98.5 per cent of CaF_2.

Beneficiation of low-grade bauxite.—In Alabama, Georgia, Tennessee, and Mississippi are large quantities of bauxite too high in silica or oxides of iron to be commercially important at present. During the past year the Southern Experiment Station of the Bureau of Mines, Birmingham-Tuscaloosa, Ala., has endeavored to ascertain whether low-grade bauxite can be concentrated by mechanical means. Silica is usually present as a part of the clay with which the bauxite is contaminated; preliminary tests indicate that the iron oxides and clay are intimately associated with the bauxite minerals. In some types of bauxite the clay and iron minerals can be freed after crushing to 28 or 35 mesh.

Search for domestic potash supplies.—In the course of the Federal Government's search for potash deposits in the United States two test wells were drilled, and a third is now being sunk in the Carlsbad (N. Mex.) area. A contract has been signed for drilling the

fourth well, in Ector County, in central western Texas. The New Mexico test wells were on lands owned by the Federal Government; potash well No. 4 will be on privately owned land. Sites for the wells are recommended by the Geological Survey; drilling operations are supervised by the Bureau of Mines.

Drilling of test wells on four sites on privately owned land in Texas was prevented by inability to negotiate drilling leases with all owners of land or mineral rights within 1 mile of the sites of the proposed wells. The potash exploration act made the landowner or mineral-rights holder liable for the cost of drilling, whether or not potash or any other valuable mineral was found. Under an amendment passed at the recent session of Congress, reimbursement to the Government of the cost of drilling is to be made only by royalties of 2½ per cent of the sale value of potash or petroleum mined and sold through the development of commercial deposits of those minerals found during the exploration. Under the amended act, the Government's lien runs only for 20 years from the signing of the contract, whereas before the passage of the amendment there had been no time limit on the Government's lien. Diamond-drilling outfits are employed in sinking these test wells. Coring of the potash-bearing salts in all wells has been successful, 98.7 per cent of the drilling footage having been obtained as core in one well. For the fiscal year 1927–28, $100,000 is available for potash exploration. It is probable that most of the drilling will be in Texas.

PETROLEUM AND NATURAL GAS

Increasing the recovery of oil from sands.—The pioneer work of various engineers of the Bureau of Mines indicates that even the most efficient commercial methods of production fail to recover half the oil in the underground sands. It is estimated that one-fifth to one-fourth is obtained by ordinary methods; this amount can sometimes be doubled by scientific repressuring of the oil sands with gas or air. Hence the general problem of increased recovery seems to divide naturally into four parts:

(1) Increasing the recovery from producing fields; (2) repressuring exhausted fields; (3) other methods of recovery—mining the oil sands, heating, vacuum, etc.; (4) fundamental studies of the flow of oil, gas, water, and mixtures of the three through the sands; studies of the structure and porosity of sands.

The use of natural gas for lifting oil from deep wells is being studied at the Petroleum Experiment Station of the bureau, Bartlesville, Okla. The mathematical and engineering principles that underlie the design and installation of lifts, or siphons, have been worked out. In the Elliott (Okla.) pool the daily production of petroleum was increased 240 per cent in less than 18 months through the use of compressed air.

A study to determine the most efficient methods of production at deep oil wells in California has been confined to collecting data on the use of compressed air and natural gas—methods in general use in the California fields.

An investigation of methods of producing oil in the fields of Pennsylvania, West Virginia, and eastern Ohio has included the

collection and analysis of data on the use of compressed air, natural gas, and water flooding to increase the recovery of oil.

A study was made in the Salt Creek (Wyo.) field to determine the most efficient method for producing oil at flowing wells by maintaining the gas-oil ratio at the minimum. A report giving the results obtained by controlling the rate of flow has appeared as a report of investigations. The tests showed that there are two distinct types of wells—one responds to the reduction of the gas-oil ratio and the other does not. Arrangements have been made for tests in other Rocky Mountain fields.

Pressure control of oil wells.—During the development of the Davenport (Okla.) oil field, a study of the pressure control of flowing wells showed that the flowing life could be lengthened and the ultimate recovery from the oil sands probably increased by careful control of pressure. For each well a point can be determined at which the maximum amount of oil can be produced with the minimum amount of gas.

Removal of paraffin deposits from oil wells.—At the Laramie (Wyo.) office a study of the accumulation of paraffin in oil wells was continued. The different wax fractions that make up the paraffin deposits were separated and their melting points and molecular weights determined. A printed report is to be published.

Mud fluid for oil and gas wells.—Investigation of the use of mud fluid was continued. Several phases of the problem were studied, including the plugging of abandoned wells. Settling tests indicated that the mud might in time settle out of the fluid so that the well would no longer be satisfactorily plugged.

Application of vacuum to oil wells.—An investigation of the application of vacuum to increase the production of oil wells was completed at the Petroleum Experiment Station. Results showed that the effectiveness of vacuum depends on local conditions at each well. If the sand is open textured vacuum may increase production; but if the sand is "tight" vacuum is useless, and may sometimes be harmful. The fact seems to be established, however, that the use of vacuum increases the gasoline content of the casing-head gas, and this increase may benefit the leaseholder after a property is greatly depleted, as his royalties on gasoline may be more important than his revenue from oil. However, experiments on high-grade and medium-grade crude oils show that at present, when the price of natural gasoline is low, leaving the gasoline in the crude would be more profitable than recovering it from the gas.

Treatment of oil-field emulsions.—Emulsions of water in oil cause enormous losses annually in the United States. In a recent two-year period 100,000,000 barrels of this cut oil, it is estimated, was produced in the Mid-Continent and Gulf Coast fields, and only half was successfully treated. As in the same period 568,039,000 barrels of crude oil was produced in the two fields, almost one-fifth of the oil production required treatment before it could be marketed, and as the average price for oil in the two fields was about $2 per barrel a total of some $200,000,000 was involved. The formation and treatment of emulsions are described in Bulletin 250, Oil-Field Emulsions, published during the year.

Use of diamond drill.—The diamond drill, widely used in prospecting for coal and ores, is being used in northern Oklahoma for determining geologic structure as well as for testing for oil. Several oil wells in Mexico and test wells in a number of States have been sunk with the diamond drill. Bulletin 243, Diamond Drilling, with Special Reference to Oil-Field Prospecting and Development, gives results of an exhaustive study.

Analyses of underground waters in oil fields.—To prevent a destructive water from entering the productive oil sand, it is essential to identify the water and determine the stratum from which it is coming. Technical Paper 404, Identification of Oil-Field Waters, issued by the bureau during the year, shows how an analysis of underground water should be reported and how a water can be identified.

Engineering reports on various oil fields.—Substantial increases in the production of oil from a number of important fields have been effected through the work of the bureau's specialists, who recommend to operators methods of repairing wells in order to control the movement of water into the oil sands. Final reports on the Powell and Wortham fields of Texas were submitted for publication; investigations were started in the Texhoma-Gose and Putnam fields in Texas; and reports on engineering problems in the northern part of the Cushing field and the Davenport field in Oklahoma were published. A study of the greater Seminole area in Oklahoma, one of the largest and most prolific oil fields ever discovered in this country, was begun.

Salvages in the oil industry.—Data obtained from the auditing departments of a number of the larger oil companies in the United States showed the value of a well-organized salvage department. A technical paper pointing out the savings that are possible by repairing used equipment is now in preparation.

Tests extend range of oils for producing lubricants.—Service tests in internal-combustion engines, at the San Francisco field office, of lubricating oils made from California crudes indicate that lubricating oils need not be refined as highly for use in automotive equipment as for use in turbines and similar machinery; thus considerable savings may be made in present refining processes. The service tests were undertaken cooperatively by the Bureau of Mines and the American Petroleum Institute. Results are given in Technical Paper 387, Engine Service Tests of Internal-Combustion Engine Lubricating Oils Made from California Crude Petroleums. During the year tests were made to determine the influence of the viscosity-volatility ratio of motor oils in engine service.

Examination of American crude petroleums.—Crude oils from several selected localities of particular interest, including the newer fields of California, the new production of Spindletop, Tex., and the Michigan fields, were examined. Special attention was paid to the oils from the Seminole area of Oklahoma. The properties of typical crudes from Venezuela are given in Serial 2807, recently issued.

During the past six years, the Bureau of Mines has made and published several hundred analyses of typical crude oils and has developed a system of interpreting analyses and of classifying crudes. The samples analyzed represent petroleum from almost all of the important producing fields in the world and of virtually every geo-

logic age. The bureau's system of interpretation is apparently adequate for classifying crudes into four main groups, and has proved convenient in studying the relationships between geologic age and the probable refinery yields of valuable products. Information on the interpretation of crude-oil analyses is contained in Serial 2806, recently published.

Chemical treatment of light petroleum distillates.—Experimental work on the chemical treatment of gasoline and similar products was continued. It included: (1) The effect of fractional distillation by different methods on the subsequent need for treating the distillate, and (2) the treatment of gasoline made from sour natural gas. As to the latter, results showed that treating the gas itself was usually cheaper and always more effective than treating the gasoline. Fractionation was studied in the belief that the deleterious substances that must be removed from gasoline by chemical treatment exist only in certain small fractions. That this belief was true has been demonstrated for several gasolines made from different crudes and for distillates from different cracking methods. The conclusion reached is that isolating and treating the offending fractions is cheaper and better than treating the gasoline as a whole.

Sulphur compounds in crude petroleum.—Sulphur compounds are among the most troublesome substances in crude petroleum. They are apt to cause corrosion and are thought to cause part of the emulsion troubles of the oil fields. Color, odor, and sourness of petroleum products are also attributable to these compounds. The problem of their constitution, removal, and possible utilization is being studied at the Petroleum Experiment Station.

Chemical study of crude petroleum.—Experimental work on Salt Creek (Wyo.) crude indicated the need for a thorough investigation of the constituents of the lubricating-oil fractions of a high-grade paraffin-base crude. Five barrels of a West Virginia crude were fractionated at low temperatures to avoid possible decomposition. After removal of the gasoline most of the wax was separated by solvents, and by a second distillation the lubricating constituents were obtained in one large fraction; this was separated, by solvents, into a series of cuts whose properties are being determined. The work has shown that crude oil contains substances far superior as lubricating oils to those commonly made by skilled refiners and is expected to yield data for working out refining methods better than those now in use. The study is also yielding data tending to establish the composition of some of the little-known compounds in crude oil.

Motor-gasoline surveys.—The customary semiannual surveys of the motor gasolines sold throughout the United States were made. Samples collected in 10 representative cities were examined. The results were reported in Serials 2765 and 2795. Little change in the quality of gasoline is apparent.

Characteristics of natural gases.—It has long been evident that differences in the natural gas of different fields have important bearings on engineering problems. The Petroleum Experiment Station is therefore making a survey of natural gas to determine the relationships between chemical analysis as ordinarily made and such little-known characteristics of the gas as viscosity and specific heat.

Gas-measurement problems.—In cooperation with the Natural Gas Association of America, the Petroleum Experiment Station has studied various factors influencing the correct measurement of natural gas. A detailed study of how constrictions and turns in pipe lines affect the metering of gas through orifice meters showed that often where a minimum length of straight and unrestricted flow on the upstream side of the meter could not be provided a straightening device could be installed in the line to correct the turbulent flow caused by an ell or gate valve.

Development of formulas for pipe-line flow.—The design of pipe lines for gas has been somewhat unsatisfactory because existing formulas, worked out to fit particular conditions, do not apply generally. In cooperation with the Natural Gas Association of America the Bureau of Mines is correlating the characteristics of various gases with flow through commercial pipe lines and studying peculiarities of construction as they affect the flow of gas. It is hoped that this study will lead to the development of a universal formula for the design of efficient pipe lines.

Saving lives in the petroleum industry.—Good progress was made during the year in interesting oil-producing companies in the adoption of safe practice and the installation of safe equipment for drilling and producing operations. Safeguarding of workmen at oil derricks is discussed in Bulletin 272. A study of safe and unsafe practices at natural gasoline plants in California was started. The safety work in the oil fields and refineries of the Mid-Continent region showed encouraging results.

Oil-shale studies.—The experimental oil-shale plant of the Bureau of Mines on Naval Oil Shale Reserve No. 3, near Rulison, Colo., was shut down June 30, 1927. The bureau had requested an appropriation of $70,000 for continuing operations another year, but the item was lost when Congress adjourned without passing the second deficiency bill.

The plant at Rulison includes a Pumpherston retort, purchased in Scotland, and an American-type retort, known as the N–T–U. After a preliminary heating period of about three months the first run of the Pumpherston retort began September 17, 1926. The retort was operated almost continuously from that date until midnight of June 30, 1927. The first run of the N–T–U retort was made January 17, 1927, and the retort was operated intermittently until June 1, 1927. In all, 2,009 tons of oil shale was run through the retorts; the yield of oil was 891 barrels, an average of 18.6 gallons per ton. The oil content of the shale charged to the retort ranged from virtually nothing to 75 gallons per ton on assay tests, although the highest average yield per ton for a single day was 42 gallons. As the yield could be varied by selective mining and arbitrary control of the grade of the charges, the total oil obtained is not a proof of the average grade of the shale in the deposit.

Approximately 150 barrels of the oil produced at the plant was sent to the Boulder (Colo.) laboratory of the Bureau of Mines for study in a $10,000 experimental refinery erected by the State of Colorado. About 100 barrels of the shale oil was sent to a number of oil refineries and laboratories for study. Results of these investigations will be given to the Bureau of Mines. Two 6,000-gallon tank cars

of the shale oil, representing oil from each retort, were sent to the League Island testing plant of the Navy Department, where it will be tested to determine its suitability as a fuel for the Navy. In cooperation with the State of Colorado laboratory tests were continued at Boulder, Colo., to determine the characteristics of oil shale and shale oil. Assay-retort tests of oil shale from various sections of the country were made, as well as tests of the oil obtained. Experiments on the nitrogen and sulphur compounds of oil shale were continued to determine the nature of these compounds and how they can be separated from shale oil. A number of nitrogen compounds were isolated and were studied to determine a possible use for them. A quantity of kerogen was separated from different oil shales and sent to the Berkeley (Calif.) station for examination. Studies of the effect of weathering on oil shale were concluded. Work was completed on comparative analyses of oil shales and coals found on the public domain, and a report was submitted for publication. Methods for refining shale oil were studied, and also the treatment of distillates from shale oil in order to obtain products of good color and odor and to remove the constituents that on standing tend to form gums.

Technical Paper 370, The Bowie-Gavin Process, issued during the year, describes a process, devised by Bureau of Mines engineers, which has recovered oil successfully, though on an experimental scale, from surface bitumen, oil shale, and oil-soaked sand. The authors indicate the possibility of recovering oil on a commercial scale from similar materials.

A manual recently issued by the bureau, Bulletin 249, gives information on apparatus and methods for testing oil shale and shale oil.

Recent articles on petroleum and allied substances.—Monthly installments of the bibliography on petroleum and allied substances were issued by the San Francisco office. Two special reports were prepared covering articles on fire hazards and safety in the petroleum industry.

Control of bentonites in well drilling.—Water is generally used in drilling for oil or other mineral substances. If bentonite is penetrated it takes up water, swells, and makes trouble. Bureau investigators formed these conclusions: A temperature change from 1° to 94° C. accelerated swelling but had little effect on the final volume of the bentonite; petroleum, kerosene, and motor oil absolutely prevent swelling, but if water were present, would form troublesome emulsions; dilute solutions of various salts retard swelling, but each type of bentonite requires a saturated solution of a specific salt if the maximum effect and a firm residue are to be obtained; probably, therefore, salts can be found which will overcome drilling troubles from all bentonites, the salt and the quantity needed being specific for each variety of bentonite.

HELIUM

Helium production for the Government was conducted by the Bureau of Mines throughout the fiscal year at United States helium production plant No. 1, on a Government reservation of approximately 28 acres, near Fort Worth, Tex. This plant was placed under

the jurisdiction of the Bureau of Mines on July 1, 1925, by act of Congress. The Linde Air Products Co., cooperating under contract with the Government, remained in charge of actual plant operations as in previous years, but under the general supervision of the bureau. This plant treats natural gas brought through the Government-owned pipe line from the Petrolia gas field, Clay County, Tex., about 104 miles north and west of Fort Worth. The helium is removed from the gas by liquefaction, and the gas minus the helium is returned to the mains for commercial use.

United States helium production plant No. 2, at the site of production plant No. 1, was completed in June, and trial runs are in progress. This plant was designed originally by a number of consulting engineers, known as the Board of Helium Engineers, but while it was being erected the Bureau of Mines engineers made some changes in its design because of work done in the cryogenic laboratory on heat interchange and the fundamental properties of gases at low temperature. Greater efficiency in the production of helium is anticipated.

For some years the bureau has been conducting a general survey of gas fields to find gases that will serve for helium production. Samples of gas from many places have been examined. Owing to the rapid decline of the Petrolia gas pool, intensive work has been under way to determine possibilities of other fields as sources of gas for large-scale production of helium over a period of years. Among the many points that have to be considered are situation of field, ownership and cost of gas rights, total gas available, number of wells (both oil and gas), field wastage, disposal of the natural gas after processing, transportation facilities, and living conditions.

Purification of helium.—During use in airships helium escapes and air enters through the cell walls; therefore at intervals the helium in an airship must be removed, purified, put back, and replenished. A mobile plant for helium purification, constructed for the Army Air Corps by the Bureau of Mines, has been in operation at Scott Field, near St. Louis, Mo., for approximately a year; it regularly delivers helium, 97.5 per cent pure, and handles between 5,000 and 6,000 feet of 80 per cent helium per hour. This plant purifies helium by liquefaction and has proved so satisfactory that the Army has requested the bureau to undertake the design and superintend the construction of a similar but much larger stationary plant embodying the same general principles. Much of the equipment, which includes compressors, motors, expansion engine, and drying towers, will be obtained from other Government sources. The Bureau of Mines will have charge of the design and purchase of special pieces of equipment; the Army Air Corps will take care of actual construction. A building for the plant is already available. The plant will have an initial capacity of 10,000 cubic feet of 80 per cent helium per hour but is designed to handle 10,000 cubic feet more when funds for additional equipment are supplied.

Cryogenic research laboratory.—The cryogenic research laboratory was established in 1921 to obtain scientific data necessary for the design and operation of equipment and plants for producing and purifying helium. The laboratory determines the properties, especially at very low temperatures, of the constituents of helium-bearing

natural gas and of various mixtures of these constituents. It also conducts experiments to determine the best designs for large-scale plants and to develop new methods that will reduce costs. The problems of the year were as follows: Liquid-vapor composition relations for methane-nitrogen mixtures, specific heats of liquefied gases, liquid-vapor composition relations for helium-bearing natural gas, and the neon content of such gas.

COAL AND OTHER SOLID FUELS—COAL PRODUCTS

Conditions in boiler furnaces.—An investigation of conditions in boiler furnaces that is being conducted under a cooperative agreement with the American Society of Mechanical Engineers has been continued. The main object is to provide makers of refractories and operators of power plants with more exact data on the temperatures and composition of the gases and the conditions in furnaces when various fuels are burned in different types of equipment. During the year work was done at four power plants, including plants using powdered coal and fuel oil. The Bureau of Standards and the University of Illinois are also cooperating.

Relation of fusibility of coal ash to formation of clinkers.—During the year research was continued, in cooperation with Carnegie Institute of Technology and two large public-service companies, for the purpose of determining whether a property of coal ash can be found which can be measured with reasonable accuracy in the laboratory and will indicate the clinkering characteristics of the coal as burned in boiler furnaces. Large users of coal have little confidence that they can insure lower operating expense and less trouble from clinker merely by buying coals with ash of high fusion point. Some 22 coals of all types have been studied. Chemical analyses and determination of ash-fusion temperature were made for the coals as received and for float-and-sink divisions of them. The coals were burned, on a semipractical scale, to obtain the fuel-bed residues, and the clinker formations were examined. Although results show that increase of clinker formation is related to decrease in ash-fusion temperature, some discrepancies indicate that the relative quantity of clinker does not depend on the ash-fusion temperature alone. Other factors that influence clinkering are being studied.

Boiler scale and its prevention.—A physicochemical study of boiler-scale formation and boiler-water conditioning was completed in cooperation with Carnegie Institute of Technology and industrial interests. It is the first fundamental study, from the viewpoint of the physical chemist, of the mechanism of scale formation and of corrosion under the conditions that prevail in steam boilers and has yielded what has been lacking—fundamental data for prescribing a rational chemical treatment of boiler water, The results should aid conservation of fuels and boiler equipment, and thus help to reduce the Nation's fuel bill. Fuel losses due to the formation of boiler scale are large.

Rating of low-pressure heating boilers.—Lack of uniformity in methods of rating low-pressure heating boilers has been a severe handicap to purchasers, who have had no assurance of the relative capacity of boilers listed by different manufacturers. During the

year the bureau cooperated with a committee of the American Society of Heating and Ventilating Engineers in the effort to develop a rating code that will be acceptable to boiler manufacturers and will protect users.

Fuel economy in Government buildings.—The fuel-economy survey of Government buildings was continued and considerable savings in the use of fuel were effected. Substitution of a smaller-size coal at the boiler plants of the navy yard and the naval hospital in Washington, D. C.; the navy yard, Norfolk, Va.; and the naval base, Hampton Roads, Va., will effect a saving of $30,000 a year. At the power plant of the Capitol in Washington a saving of about $70,000 in fuel cost was effected during the year, and when the program of changes is completed the saving is expected to be more than $100,000 yearly.

Washability of fine sizes of coal on tables.—At the Northwest Experiment Station, Seattle, Wash., a fundamental study of coal-tabling methods is in progress which includes float-and-sink tests of zonal products, screen-sizing tests, and chemical analyses. The work outlined includes the effect of the specific gravity, size, and shape of particles on the separation of coal and impurities; also effects of varying the feed, stroke, distribution and quantity of water, cross slope, and longitudinal slope of the tables. These fundamental data are applied to the cleaning of fine sizes of coal.

Through this investigation methods and apparatus have been developed by which a low-ash coal can be produced efficiently from the bony coals of the Pacific Northwest. The two most important results have been (1) the development of a special system of high, closely spaced riffles for the table, and (2) the development of a hindered-settling classifier that has the refinements and large capacity necessary for treating coal. Both developments have proved remarkably efficacious in increasing the efficiency and capacity of the table.

Several investigations have been made in cooperation with commercial companies, the most important being with a large coal company in Colorado. Washing tests at Seattle demonstrated that the ash in the company's washed coal could be lowered, and the yearly saving would be equal to many times the cost of the investigation. The results also showed that the improved methods of washing fine coal that were developed during this work in the Pacific Northwest have wide application in other fields.

Specific-gravity study of Alabama coals.—In order to devise improvements in coal-washing practice in Alabama, the characteristics of the coal and the associated impurities were studied during the year at the Southern Experiment Station. Many coal beds have thin partings of shale, "rash," and other impurities which often become mixed with the coal in mining. Usually, because of their higher specific gravity, these impurities can be separated from the coal by efficient washing plants.

Origin and constitution of coal.—Studies of the microstructure of British coals were completed by a United States Bureau of Mines specialist detailed for duty at Sheffield University, England, in cooperation with the British Safety in Mines Research Board. In turn, an investigator from the British board has been detailed to the Pittsburgh Experiment Station to study the constitution of American

coals. These joint studies have resulted in a better understanding of the coals of America and Great Britain; they enable each country to take full advantage of the studies made in the other, thus economizing effort and avoiding useless duplication. The special purpose of these researches is to obtain information that can be used in preventing spontaneous combustion and in making better coke.

Low-temperature carbonization of coal.—Because of the widespread interest in low-temperature carbonization as a possible means of producing smokeless fuels from inferior coking or noncoking coals, the bureau has kept in touch with developments. Results of research on the composition of the gases from the low-temperature carbonization of such coals were published. A study of the constitution of the tar from low-temperature carbonization of a Utah noncoking coal was continued with the aid of a fellowship of Carnegie Institute of Technology, supported by the National Coal Association. Low-temperature tar is much richer in tar acids and phenols than in high-temperature tar and therefore should ultimately prove valuable as a wood preservative.

Reactivity of coke.—Investigation of the reactivity of cokes made from the same coal in different types of coke ovens has shown that the order of reactivity for the cokes in general is the same with air, carbon dioxide, and water vapor, and is the same for pieces of 1 to 1½ inch size as for 10 to 20 mesh coke, provided all samples in each series have the same size limits. Low-temperature coke was much more reactive and more easily ignitible than high-temperature coke.

Synthetic hydrocarbons and motor fuel from water gas.—Preliminary tests of the use of catalysts at high pressures for the synthesis of methanol (wood alcohol) and other organic compounds from water gas have been made, and a study of the mechanism of these catalytic reactions at both atmospheric and higher pressures is in progress. Results of theoretical study of the possibilities have been published. Several discussions of the possible use of such processes by manufacturers of city gas, and of making motor-fuel substitutes from coal have been published in the technical press.

Problems in the gas industry of California.—Certain gas-making and fuel problems peculiar to the gas industry of California have been studied, in cooperation with the California Gas Research Council. As the continued and exclusive use of the oil-gas process depends upon a steady supply of oil at low cost, questions have arisen as to the future of gas-making processes, and whether plans for installing different gas-generating equipment will have to be made. The recommendations made by the bureau as a result of its study appear in Serial 2769.

Low-boiling hydrocarbons for enriching city gas.—Tests conducted by the bureau, in cooperation with a large petroleum-producing company, indicate that the average city gas plant making carbureted water gas can effect substantial savings by changing from gas oil to butane when the prices of oil and butane are equal. Increasing amounts of low-boiling hydrocarbons, such as propane and butane, are wasted because of the lack of a market, and their use for enriching city gas would benefit the petroleum industry.

Reducing fuel costs in manufacture of refractories.—Substantial economies were effected in the operation of plants making refrac-

tories and the quality of the wares was improved as the result of a series of firing tests conducted by Bureau of Mines engineers at seven large magnesite-brick, silica-brick, and fire-clay-brick plants in various Eastern States. Details of this investigation are contained in Bulletin 271, Problems of the Firing of Refractories, recently published.

Utilization of Nation's lignite supplies.—The possibility of making a high-grade fuel from the lignite deposits of the United States, comprising nearly one-third of the total solid-fuel resources of the Nation, has been demonstrated by the Bureau of Mines, using a cheap process for carbonizing the raw lignite to a char and subsequently briquetting this char. Extensive lignite fields lie in States west of the Mississippi, notably in North Dakota, Montana, Wyoming, Colorado, and Texas. Results of the bureau's lignite investigations are outlined in Bulletin 255, published during the year.

Fuels for intermittent oil stills.—Although the use of continuous processes and more efficient equipment for distilling oils is increasing, a large number of intermittent cylindrical stills remain in use; the fuels, methods of burning, and the construction of the furnaces vary, and their relative merits are not well understood. In response to requests from the trade, the Bureau of Mines is coordinating for publication the available data of some 200 tests it made on such stills, using both coal and oil, and varying the furnace equipment and construction to determine the effect of the changes on the fuel efficiency and the operating results.

Tests of coals in domestic furnaces.—Results of some 550 tests of the burning of 184 different coals from all parts of the United States and from foreign countries are being compiled for publication. The tests indicate what may on the average be expected, in a house-heating furnace, from a coal whose composition and burning characteristics are known.

Use of fuels in small domestic boilers.—Correct manipulation of a domestic furnace depends on the burning characteristics of the fuel bed and the constructional features of the furnace used. As study of the burning characteristics of fuel beds is not likely to be undertaken by manufacturers of furnaces, the Bureau of Mines has started an investigation, beginning with cokes. The burning characteristics, as affected by rate of burning and size of the coke pieces, have been determined for several cokes. The correct quantity of air that should be admitted over the fuel bed and its dependence on the size of the coke pieces—information of much practical value—can be deduced from these tests.

Tests of soot destroyers.—Work to determine the effectiveness of compounds sold as soot destroyers or soot preventives has continued. Various compounds as sold, and several simple salts, have been carefully tested in the laboratory and the results of their use by householders watched. Such effectiveness as the substances have is due to their lowering the ignition temperature of the soot, thus enabling it to burn at a lower temperature than it would if they were not applied, but the possibility of starting the burning depends on having a sufficiently high temperature and enough oxygen in the flue gases.

66698—27†——20

Work of coal analytical laboratory.—The work of the coal analytical laboratory at Pittsburgh consists chiefly of routine analyses of coals belonging to or for the use of the United States Government, analyses of samples collected by Bureau of Mines engineers in connection with mine-hazard investigations, and samples submitted from various research units of the bureau. Cooperative work is carried on with Maine, Maryland, New York, New Jersey, and Virginia in connection with their purchases of coal on a specification basis, with various State geological surveys, and with the American Gas Association, the American Society for Testing Materials, and the Safety in Mines Research Board of Great Britain. Samples are exchanged with several commercial laboratories to check their methods of analysis and to improve their standards.

During the fiscal year the laboratory received 10,944 samples and made 127,453 determinations. Technical papers on analyses of coals from Colorado, Montana, North Dakota, Washington, and Wyoming were submitted for publication and a technical paper on the coals of Alaska is being prepared.

COAL DIVISION OF ECONOMICS BRANCH

COAL ECONOMICS

The coal division of the economics branch makes studies and furnishes to the Government, the industry, and the public information on economic conditions and problems of the coal industry of the United States. This work relates to the industrial and commercial economics of coal, as distinguished from the scientific and technical problems, and includes the uses of coal, reserves, prices, production, distribution, consumption, stocks, and marketing. A regular feature of the division's work is the publication of monthly reports covering conditions in the domestic coal industry at the end of each month.

MINERALS AND METALS DIVISION

The duty of the division of minerals and metals is to make the following economic studies: General studies of the distribution of mineral deposits in the United States and in foreign countries so as to show relations between the two; resources at the present range of prices, and potential resources that may become available with changes in price or in technical treatment, or with increased use; uses in which the minerals are essential or nonessential; substitutes at various prices; and substitutes for minerals this country does not produce in sufficient quantity. Most of the studies appear as chapters in the volumes of Mineral Resources of the United States.

Through these studies advice on minerals can be given to such Government agencies as bureaus of the War and Navy Departments that are interested in national defense, and inquiries as to sources, quantity available, uses, and buyers and sellers can be answered.

PETROLEUM ECONOMICS DIVISION

Economic studies of the sources and distribution of major petroleum products will cover the movement of crude oil and refined

products by pipe line, tanker, and tank car from producing to consuming districts, the trends in demand for major petroleum products, and the factors governing demand. During the year reports were issued on the consumption of fuel oil by railroads, the distribution of major petroleum products in the Atlantic Coast States in 1925 and 1926, and the distribution of fuel oil on the Pacific coast in 1926.

In addition to preparing monthly and annual reports on production, stocks, and indicated demand for crude petroleum and refined products, the production of natural gas, natural gasoline, and other substances, the section of petroleum statistics prepared special reports, including "The movement of oil through the Panama Canal," "The petroleum industry a large consumer of fuel oil," "Production of gasoline by cracking," "Census of cracking plants," "Survey of petroleum pipe lines and storage capacity for crude oil and refined products," "Some economic phases of the carbon-black industry," and "Petroleum refineries in the United States on January 1, 1927."

Through questionnaires and personal interviews information was obtained on the demand for oil for domestic heating equipment, the number of household burners in use, and the grades of oil that are used for this equipment. A report covering this study is now in preparation.

MINERAL STATISTICS DIVISION

The division of mineral statistics made statistical canvasses of the production of minerals, employment and accidents at mines and quarries, and production of explosives in the United States. In collecting mineral statistics the Bureau of Mines continued to cooperate with the State geological surveys of Alabama, Florida, Georgia, Illinois, Iowa, Kansas, Maryland, Michigan, Missouri, New Jersey, New York, North Carolina, Texas, Virginia, Washington, and Wisconsin, and with the State mine inspectors of all coal-producing States.

STATISTICS ON MINERAL COMMODITIES

Through its engineers and other members in the Washington office and in its four field stations, at San Francisco, Calif., Salt Lake City, Utah, Denver, Colo., and Joplin, Mo., the division collected, for the annual mineral resources reports, statistics of mineral commodities of commercial importance. It also issued weekly reports of production of anthracite and bituminous coal; monthly reports of production, shipments, and stocks of Portland cement and the production of petroleum and petroleum products; and quarterly reports on stocks of coal and coke. Work continued on the development of statistics to show the competition of fuel oil, gas, and water power, and the progress of fuel economy. The San Francisco branch gave to the mining and chemical industries of California information on sources of and markets for mineral products. It also cooperated with various committees working with the California Development Association, with the mineral resources section of the Commonwealth Club of California, and the California Economic Research Council on problems relating to the development of the State's mineral industry, and with the State mineralogist and the California Metal and Mineral Producers' Association in the enforcement of the State law on "high grading."

The Salt Lake City section continued to prepare reports on the production of gold, silver, copper, lead, and zinc in Arizona, Idaho, Montana, Nevada, Utah, and Washington, and completed a record of metal production in the region, by mines, districts, and counties from 1903 to 1925. The Denver section prepared reports on metal production in Colorado, New Mexico, South Dakota, Wyoming, and Texas. The Joplin section prepared reports on metal production in the Central and Eastern States and statistical reports on gold and silver and the production of secondary metals in the United States. All of the division's field stations furnished information to the public regarding mining conditions within their several field districts.

Foreign mineral resources.—The section of foreign mineral resources tabulated information on the production of minerals in foreign countries; collected reports of American consular officers on the mineral resources and mining industries of foreign countries; collected reports of mining companies operating abroad; and indexed current literature on the mineral resources and industries of foreign countries.

Mine accident statistics.—The accident-statistics section compiled monthly and annual statistical reports on fatal accidents in the coal mines of the United States; collected statistics and prepared annual reports on accidents and employment at all metal mines, nonmetallic mines other than coal, quarries, coke ovens, mills, and smelters, exclusive of iron and steel plants; and compiled monthly and annual reports on the production, sales, and stocks of explosives used in mining and engineering work. This section also conducted a national contest to determine the best safety records established by mines and quarries during the calendar year 1926.

WORK IN ALASKA

The work of the Bureau of Mines in Alaska during the year was confined to the activities of the mine safety service, assaying and mineral analysis for prospectors and others, and the sampling and analysis of coal. Supervision of this work continued in charge of the supervising mining engineer for the Geological Survey in Alaska, with headquarters at Anchorage and branch offices at Juneau and Fairbanks. A fully equipped mine-rescue car, maintained by the bureau on the Alaska Railroad and available for service at coal mines adjacent to the railroad, is used for conducting first-aid and mine-rescue training. Assaying and mineral analysis are conducted at the Alaska Agricultural College and School of Mines at Fairbanks by an analytical chemist and mineralogist supplied by the Bureau of Mines. This service enables prospectors and others in Alaska to obtain official assays of samples at actual cost and to have specimens identified free of cost.

Samples of coal are analyzed at Anchorage in a well-equipped laboratory furnished by the Alaska Railroad. All coal purchased by the railroad under contract from private operators is inspected, sampled, and analyzed. The facilities of the coal-analysis service are available to other bureaus of the Government and to the public.

EDUCATIONAL MOTION-PICTURE FILMS

The Bureau of Mines has probably the largest collection of educational industrial motion-picture films in the world. These films

show the different steps in the production, treatment, and utilization of the essential mineral materials or make plain the safe methods of mining and preparing minerals. The films are produced through the cooperation of industrial concerns, who bear the entire cost of production.

On June 30, 1927, the bureau had 608 sets of films, aggregating 1,823,000 feet. The number of reels in circulation was 1,823. During the year the films were shown on 8,410 occasions before an estimated attendance of 2,381,900 persons. Distribution of the films is centralized at the experiment station at Pittsburgh, Pa., and there are 16 subdistribution centers throughout the country. The films are loaned to schools, churches, clubs, civic and business organizations, and miners' local unions. No charge is made for use, but the exhibitor is asked to pay the costs of transportation.

Very truly yours,

SCOTT TURNER,
Director, Bureau of Mines.

INTER AMERICAN HIGH COMMISSION

INTER AMERICAN HIGH COMMISSION,
Washington, July 1, 1927.

Hon. HERBERT HOOVER,
United States Section, Inter American High Commission.

MY DEAR MR. CHAIRMAN: I have the honor to present a report of the activities of the commission for the fiscal year 1926–27.

The following pamphlets have been prepared:

1. Marine Insurance and General Average—Comparative American Legislation of the York-Antwerp Rules, Spanish version.
2. Program for the Second Pan American Standardization Conference, English and Spanish versions.
3. Completion and distribution of Volume V of Report Regarding the Laws Governing Stock Corporations on the American Continent.
4. Translation into Spanish of Volume IV of Report Regarding the Laws Governing Stock Corporations on the American Continent.
5. Reprint of the pamphlet La Valorización de los Cueros Reside en el Perfeccionamiento de la Produccion.

The commission cooperated with the Pan American Union in preparation for the Third Pan American Commercial Conference. A comparative study of the consular regulations of the Latin-American countries relative to shipments was undertaken, and a mimeographed report was prepared and submitted to the conference.

The Second Pan American Standardization Conference was held at Washington from May 9 to 11, inclusive. Preparations for this conference were begun in 1926, and invitations were sent to all the Latin-American countries to participate. Fifteen countries appointed delegates, and in addition to these many of the Latin-American guests to the Third Pan American Commercial Conference attended as observers. Papers were prepared for distribution during the conference, and there was the usual routine procedure attendant on such meetings. Immediately after the conference work on the report was begun.

Data are constantly being gathered for subjects on the commission's program. During the past few months special attention has been given to regulations concerning port and inland navigation and to commercial arbitration. The cooperation of the national sections in this work has been good, and several excellent reports covering the subjects being studied have been received.

The following treaty ratifications have been effected during the past year:

The Convention on the Publication of Customs Laws has been ratified by Costa Rica, Dominican Republic, Haiti, and the United States.

The Convention on Uniform Classification of Merchandise has been ratified by the Dominican Republic, Haiti, and the United States.

The Convention on Trade-Marks has been ratified by Haiti.

Respectfully,

JULIUS KLEIN, *Secretary.*