
CENTRAL ELECTRIC LIGHT AND
POWER STATIONS

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CHAPTER I.

SCOPE AND GROUPING OF THE STATISTICS.

Central stations.—The act of Congress approved June 7, 1906, amending section 7 of the act establishing a permanent Census Office, authorizes the Director of the Census to collect every five years statistics relating to street railways, electric light and power, and the telephone and telegraph business. This report relates to central electric stations which furnish electrical energy for lighting and heating and power for manufacturing and mining purposes, for street railways and elevators, for charging batteries, etc. Central stations are classed as "commercial" and "municipal," the former being those operated by individuals, companies, and corporations; and the latter those operated by municipalities. The census takes no cognizance of electric stations that are operated by the Federal Government or of those operated primarily for the service of state institutions.

Central stations are further classed as "purely electric" and "composite." The central stations devoted solely to the generation and sale of electrical energy are designated as "purely electric." The majority of the central stations are of this class. Central stations engaged in the electric business and also in other industries, such as the manufacture of gas and the operation of waterworks, electric railways, ice plants, mining and other commercial enterprises, are designated as "composite." There is scarcely a limit to the variety of industries that are conducted under the same management with electric plants, such association of industries being the result of a belief that economy of administration is secured thereby. In many instances only one system of accounts is kept for all of the industries conducted under the same ownership, and this makes it difficult to obtain statistics which relate exclusively to the central electric light and power stations. When it was impossible to secure from book accounts exact data for the electric plants as distinct from other business, careful estimates as to the generation and sale of electric current were obtained.

No estimate could be made, however, in the case of the income and expenses that should be credited to the various phases of the business when steam was furnished for heating, or electric fixtures and supplies were sold in connection with the operation of the elec-

tric plant, and consequently the income and expenses pertaining to these transactions are included in those shown as incident to the operation of the station. Furthermore, it was often impracticable to apportion the capital among the various industries when other business was conducted in connection with the operation of the electric plant, and therefore the reported capital does not represent the amount actually chargeable to the electrical industry. The difficulty attending the segregation of capital is more fully explained in the chapter on capitalization, where an effort is made to show the capital properly chargeable to the central stations.

Municipal stations.—As already indicated, electric light and power plants operated under the ownership of municipalities and other local governments are considered as "central stations," and statistics for them are included in this report. These plants, generally established primarily to furnish current for lighting the public buildings, streets, and parks, frequently sell large quantities of electricity for commercial uses. Their field of operation is similar to that of the commercial stations, and their sources of revenue are much the same.

Although as a rule no cash income is derived from the furnishing of current for the use of the municipality, in order that the income shown in this report may represent the total consumption of electrical energy, the income for such energy furnished for municipal purposes has been estimated on the basis of what would have been paid for similar service if this service had been supplied by a commercial company in the vicinity.

The methods of conducting municipal plants, however, differ in so many important respects from those of the commercial plants that the statistics for the two classes of plants are presented separately.

Electric-railway plants and central electric stations.—The tendency to sell electricity for general commercial use is constantly increasing among electric-railway companies. It was impossible, however, in some instances, to obtain statistics concerning the capital, employees, expenses, etc., relating to the sale of electricity by railway companies for purposes similar to those reported by the central stations. As a rule but

one system of accounts is employed when the generating apparatus is used for the railway service and also for commercial light or power service, and is located in the same building and operated by the same primary power; in such cases it is impracticable to obtain separate financial statistics for the two branches of service. In all cases where separate data could be obtained, the statistics were included in the reports for the central stations and for the railways, respectively. If, however, separate returns could not be prepared, the statistics for the entire plant and equipment were included in the report on Street and Electric Railways, but certain features, such as the income from the sale of electrical energy, the number of lamps wired for service, the number of stationary motors, and the number of meters on consumption circuits, were so reported in the schedule as to enable their separate presentation, which will be found in Tables 146 to 148.

In 1902 there were 251 railway companies which furnished electricity for light, power, and other purposes. These companies reported an aggregate income of \$7,703,574 from the sale of current. In 1907 there were 330 railway companies in this class, and the income from the sale of current amounted to \$20,093,302. In 1902 the annual output of all electric stations and electric railways amounted to 4,768,535,512 kilowatt hours. In 1907 the output of the two classes of stations was 10,621,406,837 kilowatt hours, the increase in that year as compared with 1902 being 5,852,871,325 kilowatt hours, or 122.7 per cent. In 1902 the output by electric railways formed 47.4 per cent of the total, but by 1907 the proportion for such railways had decreased to 44.9 per cent. Because of consolidations of the two branches of the industry and the growing tendency of the railway companies to sell electricity for commercial purposes, the reports for the railway companies show an encroachment upon the field of the central stations, and the separate statistics for these latter stations are becoming less representative of the electrical energy sold for general commercial purposes. Nevertheless, the figures indicate that during the five years ending with 1907 the central stations increased more rapidly than the electric railways.

Isolated plants.—For the purpose of lighting and furnishing power for factories, hotels, or other enterprises, a large quantity of electricity is generated in plants which are operated for the exclusive benefit of their owners. Some of these plants sell limited amounts of current, but they were established as adjuncts to other forms of business, and practically no statistics concerning them are included in the census reports. Some of these isolated plants are extensive and have a much larger capacity than many of the central stations. At the census of 1902 it was estimated that there were 50,000 of these isolated electric plants in the United States. The number of commercial and municipal

plants increased from 3,620 in 1902 to 4,714 in 1907, the increase amounting to 1,094, or 30.2 per cent. The application of the same rate of increase to the estimated number of isolated plants in 1902 gives an estimate of 65,000 for 1907. To what extent the utilization of surplus power in the operation of private electric plants to furnish light and power for large mills, department stores, hotels, and other industrial enterprises, has stimulated the increase in these plants it is impossible to state, and the above estimate, therefore, may be more or less than the actual number of isolated plants in existence.

Power or generating plants.—Census reports are prepared as far as possible in conformity with the systems of bookkeeping in use in the different establishments. Frequently two or more power or generating plants operated under the same management had but one system of accounts, and consequently it was necessary to include the statistics for all classed as a "central station" on the same census schedule. In the vast majority of cases only one power plant is operated under the same ownership, and the term "central station" of the census classification, therefore, generally represents one plant, but it is evident that the terms "central station" and "power or generating plant" are not synonymous. Although the statistics for a central station may represent a number of these plants, every effort was made to obtain separate census reports for the plants located in separate states, even if they were conducted under the same ownership.

The number of primary-power or generating plants was not called for in the schedule used for reporting central stations in 1907, but some idea of their number may be had from the fact that the returns showed 4,731 plants equipped with dynamos for the generation of electricity. Of the 4,714 stations reported in 1907, 227 had no generating equipment, while 113 had more than one power plant. This latter class reported 357 generating stations.

Period covered.—This census relates to the calendar year ending December 31, 1907. The only other complete enumeration of the central electric stations covered the twelve months ending June 30, 1902. At both censuses reports of the establishments were accepted for the business year which most nearly conformed to the census year, and all stations that were in operation during any portion of the respective census years were included. Therefore, although most of the reports were prepared for the census year, they do not necessarily represent the same period of twelve months, or even an entire year. In 1902 reports covering a period of less than a year were furnished by 141 commercial and 38 municipal stations, and in 1907, by 202 commercial and 49 municipal stations. The majority of the reports covering less than a year were for stations that commenced operations during the census year. Some reports of this kind, however, were for

properties that changed ownership during the year, the new owners being unable to furnish statistics for the operations conducted under the previous ownership. These variations in the period covered by the reports necessarily have some influence on certain statistics, such as the output of stations. As a rule, however, the reports covering less than a year are for comparatively small plants, and the statistics for such plants have but little effect upon the various totals. The census takes no cognizance of stations that had not begun operations prior to the close of the census year, except that limited statistics are presented in Chapter VI, pages 74 and 75, for such stations as were under construction during the year.

Basis of canvass.—In the endeavor to secure statistics from all central stations lists of the names and addresses of such concerns were prepared from information obtained from the postmasters in the different cities and towns and from directories and other sources of information. These lists formed the basis of the canvass. The United States was divided into districts and each district given to one or more agents, who were instructed not only to secure reports from all stations named on the lists, but to make careful inquiry for other stations. It is believed that in this way a thorough canvass was made of the entire country and reports were secured from all plants that should be classed as "central stations."

Grouping of statistics.—Tables 118 to 145 contain all of the detailed statistics that were collected for 1907 for the central stations in each state and territory. In other tables and text statements the statistics have been grouped under appropriate headings, and comparisons made, when possible, with the data for 1902. The most important classifications of the statistics are the following:

1. Commercial central stations, or those that were operated under private ownership, whether by individuals, companies, or corporations.

2. Municipal central stations, or those that were operated by state, city, or other local governments, except those operated specially for institutions.

3. Purely electric central stations, or those that do a strictly electrical business.

4. Composite central stations, or those operated in connection with some other industry.

5. Central stations according to dynamo capacity.

6. Central stations operated by water power exclusively.

7. Central stations operated by steam power exclusively.

8. Central stations operated by both steam and water power.

9. Central stations in selected cities where all or practically all of the current is produced and consumed within the incorporated limits of the cities.

This grouping of the statistics closely follows the arrangement established at the census of 1902, in order that comparisons may be made to show the development of the industry.

The report of 1902 shows the number of central stations that commenced operations each year from 1881 to 1902, but this feature was abandoned at the census of 1907 because changes in ownership are so frequent that in many instances it is impossible to obtain the date on which operations were commenced.

The ease and practicability of long-transmission lines has caused a great extension of the area which may be covered by lines from a central station, and therefore it often happens that the generating station is located at a place which from the standpoint of population is comparatively insignificant, whereas the places at which the electrical energy is delivered for use may be of considerable size. On the other hand, many stations located in large cities are extending their service into the surrounding territory. For these reasons, a classification of central (generating) stations by the population of the places in which these stations are located would not convey a correct idea of the population served, or available for service, and consequently this presentation also, which was shown in 1902, has been abandoned.

The meager statistics concerning electric stations collected at the census of 1890 are not presented in this report because they are so fragmentary that they are not fairly comparable with those for subsequent censuses.

CHAPTER II. SUMMARY OF STATISTICS.

The magnitude of the central electric station industry in the census years 1902 and 1907, and the growth during the five-year period, are shown in Table 1.

TABLE 1.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS: 1907 AND 1902.

	TOTAL.		COMMERCIAL.		MUNICIPAL.		PER CENT OF INCREASE.		
	1907	1902	1907	1902	1907	1902	Total.	Com-mercial.	Municipal.
Number of stations.....	4,714	3,020	3,462	2,805	1,252	815	30.2	23.4	53.6
Cost of construction and equipment.....	\$1,096,913,622	\$504,740,352	\$1,054,034,175	\$482,719,879	\$42,879,447	\$22,020,473	117.3	118.4	94.7
Gross income.....	\$175,642,338	\$85,700,605	\$161,630,339	\$78,735,500	\$14,011,009	\$5,065,105	104.9	105.3	101.2
Electric service.....	\$109,614,691	\$84,186,605	\$156,000,257	\$77,349,749	\$13,614,434	\$6,830,856	101.5	101.7	99.1
Lighting.....	\$125,755,114	\$70,138,147	\$112,714,851	\$63,389,284	\$13,040,263	\$6,748,863	70.3	77.8	93.2
Stationary motors.....	\$28,511,550	\$9,910,217	\$27,995,177	\$9,839,677	\$516,373	\$70,540	187.7	184.5	632.0
All other.....	\$15,348,027	\$4,138,241	\$15,290,229	\$4,120,788	\$57,798	\$17,453	271.1	231.2	231.2
All other sources.....	\$6,027,647	\$1,514,000	\$5,630,082	\$1,385,751	\$397,565	\$128,249	208.1	306.3	210.0
Total expenses.....	\$106,205,149	\$55,457,830	\$97,037,961	\$50,716,648	\$9,167,188	\$4,741,182	91.5	91.3	93.4
Cost of supplies and materials, including power purchased.....	\$21,400,823	\$11,280,423	\$19,665,919	\$10,303,956	\$1,734,904	\$976,467	89.7	90.9	77.6
Cost of fuel.....	\$23,057,745	\$11,635,509	\$19,824,902	\$10,189,685	\$3,232,783	\$1,445,824	98.2	94.6	123.6
Miscellaneous expenses.....	\$26,326,257	\$11,895,206	\$25,611,771	\$11,456,037	\$714,486	\$439,169	121.3	123.6	62.7
Salaries and wages.....	\$35,420,324	\$20,646,692	\$31,935,309	\$18,766,970	\$3,485,015	\$1,879,722	71.6	70.2	85.4
Salaried officials, clerks, etc.—									
Number.....	12,990	6,996	11,375	6,046	1,615	950	85.7	88.1	70.0
Salaries.....	\$11,733,787	\$5,663,580	\$10,738,955	\$5,206,199	\$994,832	\$457,381	107.2	106.3	117.5
Wage-earners—									
Average number.....	34,642	23,330	30,691	20,803	3,051	2,467	48.5	47.1	60.2
Wages.....	\$23,686,537	\$14,983,112	\$21,196,354	\$13,560,771	\$2,400,183	\$1,422,341	58.1	56.3	75.1
Primary power: ¹									
Number of machines.....	10,150	7,485	8,205	6,325	1,945	1,160	35.6	29.7	67.7
Horsepower capacity.....	4,032,305	1,830,594	3,712,518	1,671,401	319,847	159,193	120.3	122.1	100.0
Steam engines and steam turbines—									
Number.....	7,206	5,930	5,492	4,870	1,714	1,060	21.5	12.8	61.7
Horsepower.....	2,627,450	1,379,941	2,344,032	1,232,923	283,418	147,018	90.4	90.1	92.8
Gas engines—									
Number.....	463	165	385	147	78	18	180.6	161.9	333.3
Horsepower.....	55,828	12,181	49,746	11,224	6,082	957	358.3	343.2	535.5
Water wheels—									
Number.....	2,481	1,390	2,328	1,308	153	82	78.5	78.0	86.0
Horsepower.....	1,349,087	438,472	1,318,740	427,254	30,347	11,218	207.7	208.7	170.5
Generating equipment:									
Dynamos									
Number.....	12,173	12,484	9,778	10,662	2,395	1,822	2.5	8.3	31.4
Kilowatt capacity.....	2,709,225	1,212,235	2,500,209	1,098,855	209,016	113,380	123.5	127.5	84.3
Direct-current, constant-voltage—									
Number.....	3,680	3,823	3,169	3,405	511	418	3.7	6.9	22.2
Kilowatt capacity.....	406,460	330,065	379,706	312,509	26,754	17,556	23.1	21.5	52.4
Direct-current, constant-amperage—									
Number.....	1,685	3,539	1,246	2,957	439	582	52.4	57.9	24.6
Kilowatt capacity.....	80,992	145,866	61,753	117,695	19,239	28,171	44.5	47.5	31.7
Alternating single-phase and poly-phase current—									
Number.....	6,808	5,122	5,303	4,300	1,445	822	32.9	24.7	75.8
Kilowatt capacity.....	2,221,773	730,304	2,058,750	668,651	163,023	67,653	201.7	207.9	141.0
Output of stations, kilowatt hours.....	5,862,276,737	2,507,051,115	5,572,813,949	2,311,146,676	289,402,788	195,904,439	133.8	141.1	47.8
Lamps wired for service: ⁴									
Arc.....	555,713	385,698	472,773	334,903	82,940	50,795	44.1	41.2	63.3
Incandescent ⁵	41,445,997	18,194,044	37,393,549	16,616,563	4,052,448	1,577,451	127.8	125.0	156.9
Other varieties—Nernst, vacuum, vapor, etc.....	162,338	(⁶)	153,468	(⁶)	8,870	(⁶)			

¹ Includes the estimated income for current consumed in municipal buildings and in lighting streets, parks, etc.
² Exclusive of auxiliary engines with a total capacity of 65,823 horsepower in 1907 and 14,454 horsepower in 1902.
³ Decrease.
⁴ Exclusive of 275,079 lamps used by the central stations to light their own electric properties in 1907. These lamps were not reported separately in 1902.
⁵ The number of incandescent lamps was largely an estimate and, although mostly reported on a 16-candlepower basis, embraces a considerable number ranging from 2 to 50 candlepower.
⁶ Not reported separately.

As previously explained, the figures for the central stations do not represent the entire production of electrical energy. To arrive at the aggregate it would be necessary to consider also the electric railways, telephone and telegraph lines, electric police-patrol and fire-alarm systems, and the isolated electric plants.

In 1907, exclusive of the isolated electric plants, there were upward of 30,000 individuals, companies, corporations, and municipalities which reported the

generation or utilization of electric current in what may be termed "commercial enterprises." These industries represent an outstanding capitalization of \$6,209,746,753, of which \$1,367,338,836 is credited to central electric stations, \$3,774,772,096 to electric railways, \$814,616,004 to commercial or mutual telephone companies, and \$253,019,817 to telegraph companies, the latter item including \$32,726,242, the capital stock of wireless-telegraph companies. The capitalization of

the 17,702 independent farmer or rural telephone lines and of the 1,157 electric police-patrol and fire-alarm systems could not be ascertained. In addition, there were a number of companies organized for the purpose of acquiring the capital stock or bonds of electric companies, street railways, gas and water systems, and similar properties, holding the same for investment and to some extent supervising the operation of the underlying companies. To show the capitalization of these holding companies would be misleading as applied to central electric stations, since it would be impossible to determine the extent of its application to the electrical industry as distinguished from others. In view of this condition and because of the difficulty of securing the information, it was deemed advisable to omit the data as relating to central stations.

In view of the very large increases shown for the details of the industry as a whole, it seems necessary to state that the loss shown in the number and the capacity of the direct-current machines was due to the fact that this type of dynamo has been superseded by the alternating single-phase and polyphase current machine.

Although central-station statistics of the comparatively few street railways that sold current and that were able to prepare complete separate reports have been included with those for central electric stations, in order that that branch of the electrical industry might be shown as fully as possible, the full measure of growth of central-station work does not appear in Table 1 because of the fact that this service is also largely carried on by numerous street-railway companies which combine the central-station business so closely with other activities as not to permit of complete separate reports. Detailed statistics for the electric-railway companies which were unable to make separate reports will be found in Tables 146, 147, and 148, and a brief summary of the same is presented in Table 2.

TABLE 2.—Central electric stations operated by street-railway companies: 1907 and 1902.

[Complete separate reports for these stations could not be secured, hence the full statistics for them have been included with those for electric railways. This table does not include central stations operated by street-railway companies which furnished complete separate reports.]

	1907	1902	Per cent of increase.
Number of stations.....	177	118	50.0
Gross income.....	\$17,291,824	\$6,469,720	167.3
Electric service.....	\$16,576,555	\$6,271,815	164.3
Lighting.....	\$13,273,295	\$5,492,669	141.7
Stationary motors.....	\$2,685,013	\$768,040	249.6
All other.....	\$618,247	\$11,106	5,466.8
All other sources.....	\$715,269	\$197,911	261.4
Lamps wired for service:			
Arc.....	80,102	33,863	136.5
Incandescent ¹	4,545,839	1,442,685	215.1
Other varieties—Nernst, vacuum, vapor, etc.....	28,641	(?)	.....
Stationary motors:			
Number.....	20,468	10,049	103.7
Horsepower.....	158,923	35,688	345.3
Meters on consumption circuits, number.....	213,886	56,601	277.9

¹ The number of incandescent lamps was largely an estimate and, although mostly reported on a 16-candlepower basis, embraces a considerable number ranging from 2 to 50 candlepower.

² Not reported separately.

Table 2 shows that while the number of stations which were unable to make separate reports is growing, there is still greater increase in their importance. The increase in the income for electric service, \$10,822,098, does not fully represent this feature of the electric service, since, as shown in the report on street railways, 330 companies reported the sale of electric current during 1907, and the income from this source amounted to \$20,093,302. Some of the current was sold to other electric railways, but a large portion was used for light and power in enterprises not connected with the railways. However, statistics of income and equipment can be shown separately for only 177 companies. The increases in number of lamps, number and horsepower of stationary motors, and number of meters on consumption circuits, not only show the rapid growth of central-station work in connection with the operation of street railways, but demonstrate the wonderful facility with which electrical energy may be utilized wherever there is a demand for light or power.

Ownership of central electric stations.—Table 3 shows the number of commercial central stations conducted under the different forms of ownership.

TABLE 3.—Commercial central electric stations—Number, by character of ownership: 1907 and 1902.

CHARACTER OF OWNERSHIP.	1907	1902	Per cent of increase.	PER CENT DISTRIBUTION.	
				1907	1902
Total.....	3,462	2,805	23.4	100.0	100.0
Individual.....	609	528	15.3	17.6	18.8
Firm.....	298	228	30.7	8.6	8.1
Incorporated company.....	1,2,555	2,049	24.7	73.8	73.1

¹ Includes 2 stations classed as "Other forms of ownership," in order that the operations of individual stations may not be disclosed.

Although the number of stations operated by the several forms of ownership can not properly be used to determine their relative importance, it shows the character of ownership which predominates and which seems to be one of the distinctive features of the industry. Nearly three-fourths of the stations reported at each census were operated by incorporated companies. Individual ownership was next in importance as to number of stations, with less than one-fifth of the total at each census. The percentage which stations under individual ownership represent of the total number for all classes decreased from 18.8 in 1902 to 17.6 in 1907, a loss of 1.2. Firms showed but little proportionate change, having less than 9 per cent of the total number at each census. Detailed statistics for 1907 for the different forms of ownership are presented in Table 4. These statistics are confined to 1907 because in 1902 data as to character of ownership were limited to the number of establishments.

CENTRAL ELECTRIC LIGHT AND POWER STATIONS.

TABLE 4.—COMMERCIAL CENTRAL ELECTRIC STATIONS, BY CHARACTER OF OWNERSHIP: 1907.

	CHARACTER OF OWNERSHIP.			
	Total.	Individual.	Firm.	Incorporated company. ¹
Number of stations.....	3,462	609	298	2,555
Cost of construction and equipment.....	\$1,054,034,175	\$6,574,920	\$4,019,813	\$1,043,439,442
Gross income.....	\$161,630,339	\$2,371,467	\$1,478,134	\$157,780,738
Electric service.....	\$150,000,257	\$2,202,102	\$1,408,139	\$152,330,016
Lighting.....	\$112,714,851	\$2,130,822	\$1,273,793	\$109,310,236
Stationary motors.....	\$27,995,177	\$80,528	\$96,801	\$27,817,848
All other.....	\$15,290,229	\$50,752	\$37,545	\$15,201,932
All other sources.....	\$5,630,082	\$109,365	\$99,995	\$5,450,722
Total expenses.....	\$97,037,961	\$1,615,426	\$1,021,788	\$94,400,747
Cost of supplies and materials.....	\$12,969,731	\$231,471	\$175,456	\$12,562,804
Cost of fuel.....	\$19,824,962	\$560,453	\$317,940	\$18,946,563
Power purchased.....	\$6,096,188	\$58,157	\$40,590	\$6,597,441
Miscellaneous expenses.....	\$25,611,771	\$206,510	\$119,562	\$25,285,699
Salaries and wages.....	\$31,935,309	\$558,835	\$308,234	\$31,068,240
Salaried officials, clerks, etc.—				
Number.....	11,375	171	139	11,065
Salaries.....	\$10,738,955	\$112,065	\$89,614	\$10,536,676
Wage-earners—				
Average number.....	30,691	863	495	29,333
Wages.....	\$21,196,354	\$446,170	\$278,620	\$20,471,564
Primary power.....				
Number of machines.....	8,981	847	436	7,698
Horsepower capacity.....	3,770,837	74,608	47,025	3,655,144
Steam engines—				
Number.....	5,144	520	285	4,339
Horsepower.....	1,546,007	50,062	30,034	1,465,311
Steam turbines—				
Number.....	348	1		347
Horsepower.....	798,025	30		797,995
Gas engines—				
Number.....	385	83	37	265
Horsepower.....	49,746	3,577	1,399	44,770
Water wheels—				
Number.....	2,328	209	103	2,016
Horsepower.....	1,318,740	18,751	14,957	1,285,032
Auxiliary engines—				
Number.....	776	34	11	731
Horsepower.....	64,319	1,648	635	62,036
Generating equipment:				
Dynamos—				
Number.....	9,778	839	412	8,527
Kilowatt capacity.....	2,500,209	44,315	28,511	2,427,383
Direct-current, constant-voltage—				
Number.....	3,169	403	193	2,573
Kilowatt capacity.....	379,706	15,365	6,981	357,300
Direct-current, constant-amperage—				
Number.....	1,246	39	17	1,190
Kilowatt capacity.....	61,753	1,014	407	60,332
Alternating single-phase and polyphase current—				
Number.....	5,363	397	202	4,764
Kilowatt capacity.....	2,058,750	27,936	21,123	2,009,691
Output of stations, kilowatt hours.....	5,572,813,949	43,103,493	41,357,746	5,488,352,710
Lamps wired for service: ²				
Arc.....	472,773	5,758	3,021	463,994
Incandescent ³	37,393,649	736,594	406,116	36,250,839
Other varieties—Nernst, vacuum, vapor, etc.....	153,468	625	355	152,488

¹ Includes 2 stations classed as "Other forms of ownership" in order that the operations of individual stations may not be disclosed.

² Exclusive of 275,079 lamps used by the central stations to light their own electric properties.

³ The number of incandescent lamps was largely an estimate and, although mostly reported on a 16-candlepower basis, embraces a considerable number ranging from 2 to 50 candlepower.

The statistics in Table 4 show the great preponderance of corporate ownership. The proportions contributed by the corporations to several of the chief totals of the table were as follows: Cost of construction and equipment, 99 per cent; income from sale of current, 97.6 per cent; primary horsepower, 96.8 per cent; kilowatt capacity of dynamos, 97.1 per cent; output of stations, 98.5 per cent; number of arc lamps, 98.1 per cent; and number of incandescent lamps, 96.9 per cent. If the municipal stations were included, the proportions for incorporated companies would be less, but they would still represent about 90 per cent of the several totals, while of the remaining 10 per cent, roughly speaking, about 2 per cent may be assigned to individuals and firms, with individual ownership having somewhat the larger share, and 8 per cent to municipalities.

As already stated, central stations may be divided into the purely electric, those which were operated solely as electrical enterprises; and the composite,

those which were operated in connection with some other industry or service, such as waterworks, gas plants, etc. Table 5 gives detailed statistics of these two classes of stations subdivided by character of ownership.

A comparison of the totals for the two groups of stations shows that about three-fifths of the income and cost of construction and equipment was connected with the purely electric and two-fifths with the composite stations. Nearly two-thirds of the commercial central stations were reported as purely electric, and something more than one-third as composite. This division of commercial stations may also be accepted as roughly representing the respective importance of the purely electric and the composite stations. While the proportions for the chief items for the commercial stations are thus decidedly greater in the purely electric than in the composite class, this does not hold true for the municipal stations, where such important totals as income, expenses, horsepower of primary-

power plant, kilowatt capacity of dynamos, and number of incandescent lamps are greater for the composite stations. The fact that such public utilities as water and gas are so often operated by municipalities which also operate electric stations explains this condition. Nearly four-fifths of the purely electric central stations

and more than three-fifths of those in the composite group were commercial stations. Exclusive of the item of arc lamps, about 6 per cent of the income and equipment of the purely electric group was reported by the municipal stations, as compared with about 10 per cent for these stations in the composite group.

TABLE 5.—PURELY ELECTRIC AND COMPOSITE CENTRAL ELECTRIC STATIONS, BY CHARACTER OF OWNERSHIP: 1907.

	Total.	PURELY ELECTRIC STATIONS.				COMPOSITE STATIONS.			
		Commercial.			Municipal.	Commercial.			Municipal.
		Individual.	Firm.	Incorporated company. ¹		Individual.	Firm.	Incorporated company.	
Number of stations.....	4,714	397	175	1,555	521	212	123	1,000	731
Cost of construction and equipment.....	\$1,006,913,622	\$4,427,517	\$2,201,942	\$632,717,815	\$23,489,640	\$2,147,403	\$1,727,871	\$410,721,627	\$19,389,807
Gross income.....	\$175,642,338	\$1,606,500	\$863,938	\$98,751,829	\$6,752,654	\$764,967	\$614,196	\$59,028,909	\$7,259,345
Electric service.....	\$169,614,691	\$1,538,157	\$813,222	\$95,705,459	\$6,572,736	\$723,945	\$594,917	\$56,624,557	\$7,041,698
Lighting.....	\$125,755,114	\$1,442,855	\$751,275	\$67,189,245	\$6,294,677	\$687,967	\$522,518	\$42,120,991	\$6,745,586
Stationary motors.....	\$25,511,550	\$63,834	\$35,121	\$17,852,985	\$261,061	\$16,694	\$61,680	\$9,064,863	\$255,312
All other sources.....	\$15,348,027	\$31,468	\$26,826	\$10,663,229	\$16,998	\$19,284	\$10,719	\$4,538,703	\$40,800
Total expenses.....	\$6,027,647	\$68,343	\$50,716	\$3,046,370	\$179,918	\$41,022	\$19,279	\$2,404,352	\$217,647
Cost of supplies and materials.....	\$106,205,149	\$1,078,567	\$580,033	\$57,456,650	\$4,374,925	\$536,859	\$441,755	\$36,044,097	\$4,792,263
Cost of fuel.....	\$14,326,351	\$155,112	\$96,035	\$7,360,405	\$678,961	\$76,359	\$79,421	\$5,202,399	\$677,659
Power purchased.....	\$23,057,745	\$374,037	\$185,345	\$10,592,454	\$1,324,732	\$186,416	\$132,601	\$8,354,109	\$1,908,051
Miscellaneous expenses.....	\$7,074,472	\$56,278	\$27,237	\$4,598,100	\$277,904	\$1,879	\$13,353	\$1,999,341	\$100,380
Salaries and wages.....	\$26,326,257	\$137,143	\$65,721	\$16,314,907	\$331,600	\$69,367	\$53,841	\$8,970,792	\$382,886
Salaries of officials, clerks, etc.—	\$35,420,324	\$355,967	\$205,695	\$18,590,784	\$1,761,728	\$202,838	\$162,539	\$12,417,456	\$1,723,287
Wage-earners—									
Number.....	12,900	100	78	6,469	615	71	61	4,596	1,000
Salaries.....	\$11,733,787	\$65,261	\$50,325	\$6,438,363	\$406,875	\$47,404	\$39,289	\$4,098,313	\$587,957
Average number.....	34,642	555	272	17,494	1,941	308	223	11,839	2,010
Wages.....	\$23,686,537	\$290,736	\$155,370	\$12,152,421	\$1,354,853	\$155,434	\$123,250	\$8,319,143	\$1,135,330
Primary power:									
Number of machines.....	10,998	532	242	4,446	819	315	194	3,252	1,198
Horsepower capacity.....	4,098,188	48,370	25,440	2,250,483	149,018	26,298	21,685	1,404,661	172,333
Steam engines—									
Number.....	6,829	339	160	2,343	657	181	125	1,996	1,028
Horsepower.....	1,810,040	34,082	16,820	785,663	113,729	16,580	13,214	679,648	150,304
Steam turbines—									
Number.....	377			181	11	1		166	18
Horsepower.....	817,410			596,712	10,150	30		201,283	9,235
Gas engines—									
Number.....	463	66	30	166	33	17	7	99	45
Horsepower.....	55,828	2,867	1,049	18,736	2,796	710	350	26,034	3,286
Water wheels—									
Number.....	2,481	104	44	1,343	84	105	59	673	69
Horsepower.....	1,349,087	10,535	7,326	824,211	21,813	8,216	7,631	460,821	8,534
Auxiliary engines—									
Number.....	848	23	8	413	34	11	3	318	38
Horsepower.....	65,823	886	245	25,161	530	762	390	36,875	974
Generating equipment:									
Dynamos—									
Number.....	12,173	556	251	4,878	1,064	283	161	3,649	1,331
Kilowatt capacity.....	2,709,225	29,620	16,477	1,528,189	96,528	14,695	12,034	899,194	112,488
Direct-current, constant-voltage—									
Number.....	3,680	257	121	1,409	228	146	72	1,164	283
Kilowatt capacity.....	406,460	10,357	4,370	196,380	11,360	5,008	2,611	160,980	15,394
Direct-current, constant-amperage—									
Number.....	1,685	34	12	732	266	5	5	458	173
Kilowatt capacity.....	80,992	919	304	38,040	12,241	95	103	22,292	6,998
Alternating, single-phase and polyphase current—									
Number.....	6,808	265	118	2,737	570	132	84	2,027	875
Kilowatt capacity.....	2,221,773	18,344	11,803	1,293,769	72,927	9,592	9,320	715,922	90,096
Output of stations, kilowatt hours.....	5,862,276,737	27,704,477	15,193,414	3,692,080,449	145,109,547	15,399,016	26,164,332	1,796,272,261	144,353,241
Lamps wired for service: ²									
Arc.....	555,713	4,055	1,924	280,101	48,206	1,703	1,097	183,893	34,734
Incandescent ³	41,445,997	522,444	245,456	21,852,656	1,710,564	214,150	160,660	14,398,183	2,341,884
Other varieties—Nernst vacuum, vapor, etc.....	162,338	447	262	112,069	5,575	178	93	40,419	3,295

¹ Includes 2 stations classed as "Other forms of ownership," in order that the operations of individual stations may not be disclosed.

² Exclusive of 275,079 lamps used by the central stations to light their own electric properties.

³ The number of incandescent lamps was largely an estimate and, although mostly reported on a 16-candlepower basis, embraces a considerable number ranging from 2 to 50 candlepower.

Table 6 presents a comparative summary of the purely electric and the composite plants for 1907 and 1902.

The percentages of increase for the composite stations are much greater than for the purely electric, but the absolute increases show no such excess. On the contrary, the purely electric stations show a

greater absolute increase for all the leading items. It is noteworthy that both the commercial and the municipal stations share in the uniformly larger percentages of increase for the composite stations, which appears to indicate that the distinctive characteristics of the two classes of stations are much less marked than formerly.

CENTRAL ELECTRIC LIGHT AND POWER STATIONS.

TABLE 6.—PURELY ELECTRIC AND COMPOSITE CENTRAL ELECTRIC STATIONS—COMMERCIAL AND MUNICIPAL: 1907 AND 1902.

	Census.	Aggregate.	PURELY ELECTRIC STATIONS.			COMPOSITE STATIONS.		
			Total.	Commercial.	Municipal.	Total.	Commercial.	Municipal.
Number of stations.....	1907	4,714	2,648	2,127	521	2,066	1,335	731
	1902	3,620	2,139	1,759	380	1,481	1,046	435
Per cent of increase.....		30.2	23.8	20.9	37.1	39.5	27.6	68.0
Cost of construction and equipment.....	1907	\$1,096,913,622	\$662,926,914	\$639,437,274	\$23,489,640	\$433,986,708	\$414,596,901	\$19,389,807
	1902	\$504,740,352	\$334,151,724	\$320,580,333	\$13,571,391	\$170,588,628	\$162,139,546	\$8,449,082
Per cent of increase.....		117.3	98.4	99.5	73.1	154.4	155.7	129.5
Gross income.....	1907	\$175,642,338	\$107,974,921	\$101,222,267	\$6,752,654	\$67,667,417	\$60,408,072	\$7,259,345
	1902	\$85,700,605	\$58,603,406	\$54,455,737	\$4,147,669	\$27,097,199	\$24,279,763	\$2,817,436
Per cent of increase.....		104.9	84.2	85.9	62.8	149.7	107.6	157.7
Electric service.....	1907	\$169,614,691	\$104,629,574	\$98,056,838	\$6,572,736	\$64,685,117	\$57,943,419	\$7,041,694
	1902	\$84,186,605	\$57,470,597	\$53,394,158	\$4,076,439	\$26,716,008	\$23,955,591	\$2,760,417
Per cent of increase.....		101.5	82.1	83.6	61.2	143.2	141.9	155.1
All other sources.....	1907	\$6,027,647	\$3,345,347	\$3,165,429	\$179,918	\$2,682,300	\$2,464,653	\$217,647
	1902	\$1,514,000	\$1,132,809	\$1,061,579	\$71,230	\$381,191	\$324,172	\$57,019
Per cent of increase.....		298.1	195.3	198.2	152.6	603.7	660.3	281.7
Total expenses.....	1907	\$106,205,149	\$63,490,175	\$59,115,250	\$4,374,925	\$42,714,974	\$37,922,711	\$4,792,263
	1902	\$55,487,830	\$37,272,578	\$34,525,512	\$2,747,066	\$18,185,252	\$16,191,136	\$1,994,116
Per cent of increase.....		91.5	70.3	71.2	59.3	134.9	134.2	140.3
Primary power: ¹								
Number of machines.....	1907	10,150	5,561	4,776	785	4,589	3,429	1,160
	1902	7,485	4,615	4,032	583	2,870	2,203	577
Per cent of increase.....		35.6	20.5	18.5	34.7	59.9	49.5	101.0
Horsepower capacity.....	1907	4,032,365	2,446,489	2,298,001	148,488	1,585,876	1,414,517	171,350
	1902	1,830,594	1,242,362	1,151,520	90,842	588,232	519,881	68,351
Per cent of increase.....		120.3	96.9	99.6	63.5	169.6	172.1	150.7
Generating equipment:								
Dynamos—								
Number.....	1907	12,173	6,749	5,685	1,064	5,424	4,003	1,331
	1902	12,484	7,752	6,733	969	4,732	3,879	854
Per cent of increase.....		*2.5	*12.9	*16.2	9.8	14.6	5.5	56.0
Kilowatt capacity.....	1907	2,709,225	1,670,814	1,574,286	96,528	1,038,411	925,923	112,488
	1902	1,212,285	818,805	753,021	65,784	393,430	345,834	47,646
Per cent of increase.....		123.5	104.1	109.1	46.7	163.9	167.7	136.3
Output of stations, kilowatt hours.....	1907	5,862,276,737	3,880,087,887	3,734,978,340	145,109,547	1,982,188,850	1,837,835,609	144,353,241
	1902	2,507,051,115	1,836,748,836	1,716,909,602	119,839,234	670,302,279	594,237,074	76,065,205
Per cent of increase.....		133.8	111.2	117.5	21.1	195.7	209.3	89.4
Lamps wired for service: ²								
Arc.....	1907	555,713	334,286	286,080	48,206	221,427	186,693	34,734
	1902	385,698	252,407	219,409	32,998	133,291	115,494	17,797
Per cent of increase.....		44.1	32.4	30.4	46.1	66.1	61.6	95.2
Incandescent ³	1907	41,445,997	24,331,120	22,620,556	1,710,564	17,114,877	14,772,993	2,341,884
	1902	18,194,044	12,248,918	11,463,050	785,868	5,945,126	5,153,543	791,584
Per cent of increase.....		127.8	98.6	97.3	117.7	187.9	186.7	105.4
Other varieties—Nernst, vacuum, vapor, etc. ⁴	1907	162,338	118,353	112,778	5,575	43,985	40,690	3,295

¹ Exclusive of auxiliary engines with a total capacity of 65,823 horsepower in 1907 and 14,454 horsepower in 1902.

² Decrease.

³ Exclusive of 275,079 lamps used by the central stations to light their own electric properties in 1907. These lamps were not reported separately in 1902.

⁴ The number of incandescent lamps was largely an estimate and, although mostly reported on a 16-candlepower basis, embraces a considerable number ranging from 2 to 50 candlepower.

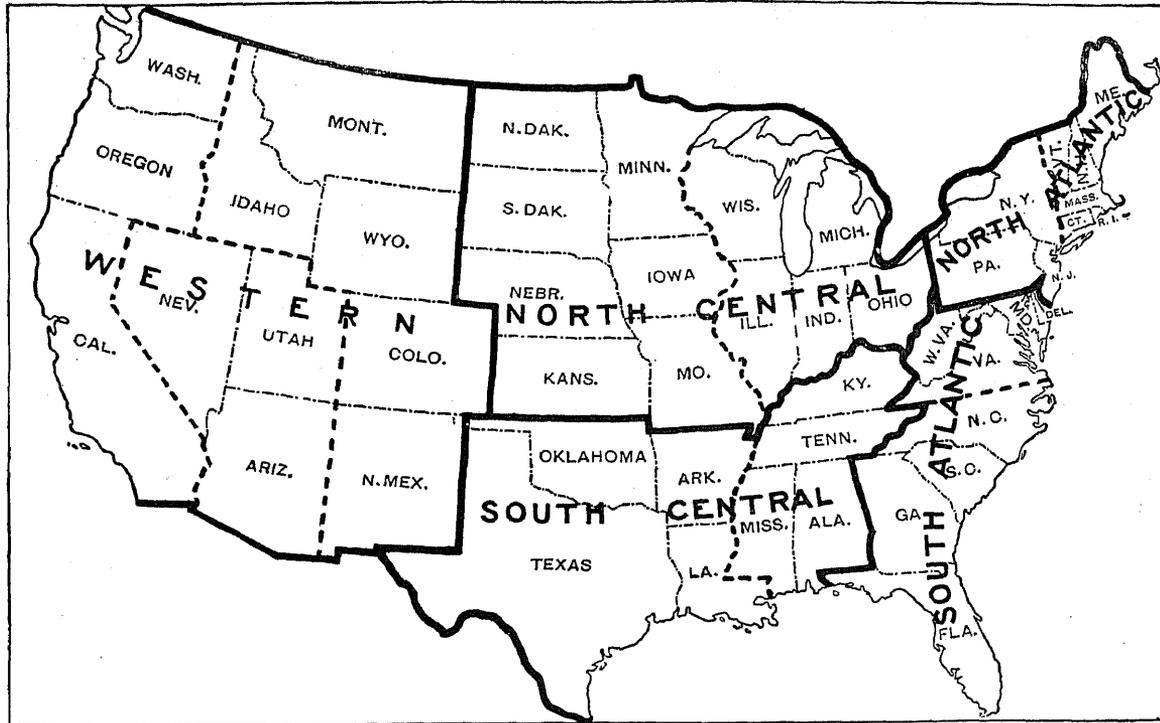
⁵ Not reported separately in 1902.

Relationship of population and central stations.—As a rule, the central electric stations are concentrated in the most populous states and at points within these states from which the largest percentage of the population can be served economically. From Table 119 it appears that New York, Pennsylvania, Illinois, and Ohio, the 4 states having the largest population, containing together 29.6 per cent of the total for the United States, reported 1,296 electric stations, or 27.5 per cent of the total number in operation during 1907, and the annual output of these stations amounted to 2,553,745,890 kilowatt hours, or 43.6 per cent of the output of all stations in the United States. While

the proportionate number of central stations and the proportionate population of this group of states were very nearly the same, or less than one-third of the total, their proportion of the kilowatt-hour output formed nearly one-half of the total. In 1902 the exact percentages for these items were as follows: Population, 29.7 per cent; number of establishments, 30.8 per cent; and kilowatt-hour output, 49.1 per cent.

A number of the tables contained in this report present the statistics by the officially adopted geographic divisions. An outline and a list follow, showing the states and territories contained in each division:

MAP 1.—GEOGRAPHIC DIVISIONS.



North Atlantic division:

- Maine.
- New Hampshire.
- Vermont.
- Massachusetts.
- Rhode Island.
- Connecticut.
- New York.
- New Jersey.
- Pennsylvania.

South Atlantic division:

- Delaware.
- Maryland.
- District of Columbia.
- Virginia.
- West Virginia.
- North Carolina.
- South Carolina.
- Georgia.
- Florida.

North Central division:

- Ohio.
- Indiana.
- Illinois.
- Michigan.
- Wisconsin.
- Minnesota.
- Iowa.

North Central division—Continued.

- Missouri.
- North Dakota.
- South Dakota.
- Nebraska.
- Kansas.

South Central division:

- Kentucky.
- Tennessee.
- Alabama.
- Mississippi.
- Louisiana.
- Arkansas.
- Oklahoma.
- Texas.

Western division:

- Montana.
- Idaho.
- Wyoming.
- Colorado.
- New Mexico.
- Arizona.
- Utah.
- Nevada.
- Washington.
- Oregon.
- California.

38.9 and 42.7 per cent; output of stations, 42.4 and 50.6 per cent; number of arc lamps, 43.6 and 44 per cent; and number of incandescent lamps, 41.5 and 47.1 per cent.

The South Atlantic and South Central divisions, treated as a single group, embraced 32.7 per cent of the population in 1907 and 32.4 per cent in 1902. Although their proportions of the various items of the central-station industry were larger in 1907 than in 1902, they were the smallest shown for any section of the country. The exact percentages for each of these two divisions for 1907 and 1902 were as follows: South Atlantic, population, 13.5 and 13.7 per cent, respectively; horsepower of primary-power plant, 7.2 and 5 per cent; kilowatt capacity of dynamos, 7.2 and 5.1 per cent; output of stations, 4.5 and 4.1 per cent; number of arc lamps, 4.9 and 4.5 per cent; and number of incandescent lamps, 4.6 and 3.4 per cent. The South Central, population, 19.1 and 18.6 per cent; horsepower of primary-power plant, 6 and 6.4 per cent; kilowatt capacity of dynamos, 6.1 and 6.8 per cent; output of stations, 4.4 and 6.1 per cent; number of arc lamps, 7.2 and 6 per cent; and number of incandescent lamps, 6.5 and 5.6 per cent. The Western division was the smallest in population, with 5.6 per cent of the total in 1907 and 5.5 per cent in 1902. Its percentages of the various items for the central-station industry for 1907 and 1902, respectively, were as follows: Horsepower of primary-power plant, 19.6 and 15.2 per cent; kilowatt capacity of dynamos, 18 and 14.4 per cent; output of stations, 23.8 and 13.4 per cent; number of arc lamps, 7.6 and 7.8 per cent; and number of incandescent lamps, 13 and 10 per cent.

The largest proportion of the total population of the country, 33.9 per cent in 1907 and 34.5 per cent in 1902, was in the North Central states. These states also contained nearly the same percentage of electric lamps wired for service, but for the horsepower of primary-power plants, kilowatt capacity of dynamos, and output of stations, the percentages were considerably less. The North Atlantic states were next in the proportion of population, with 27.8 per cent in 1907 and 27.7 per cent in 1902, but their proportions for the various items of the central-station industry for both 1907 and 1902 were much larger, as follows: Horsepower of primary-power plant, 37.4 and 44.2 per cent, respectively; kilowatt capacity of dynamos,

CENTRAL ELECTRIC LIGHT AND POWER STATIONS.

TABLE 7.—CENTRAL ELECTRIC STATIONS—RELATION OF LEADING ITEMS TO POPULATION, BY GEOGRAPHIC DIVISIONS: 1907 AND 1902.

DIVISION.	Cen-sus.	Popu-lation. ¹	NUMBER OF STATIONS.			HORSEPOWER OF ENGINES AND WATER WHEELS. ²		KILOWATT CAPACITY OF DYNAMOS.		OUTPUT OF STATIONS, KILOWATT HOURS.		LAMPS. ³			
			Total.	Com-mer-cial.	Municipal.	Amount.	Per 1,000 popu-lation.	Amount.	Per 1,000 popu-lation.	Amount.	Per 1,000 popu-lation.	Arc.		Incandescent. ⁴	
												Number.	Per 1,000 popu-lation.	Number.	Per 1,000 popu-lation.
United States.....	1907	85,532,761	4,714	3,462	1,252	4,098,188	47.91	2,709,225	31.67	5,862,276,737	68,538.38	555,713	6.50	41,445,997	484.56
	1902	78,576,436	3,620	2,805	815	1,845,048	23.48	1,212,235	15.43	2,507,051,115	31,905.80	385,698	4.91	18,194,044	231.55
Per cent of in-crease.....		8.9	30.2	23.4	53.6	122.1	.....	123.5	.....	133.8	.....	44.1	.....	127.8	.....
North Atlantic.....	1907	23,779,013	1,070	920	150	1,534,586	64.54	1,054,528	44.35	2,483,106,227	104,424.28	242,320	10.19	17,187,474	722.80
	1902	21,778,196	913	810	103	814,728	37.41	517,549	23.76	1,269,331,001	58,284.49	169,554	7.79	8,561,205	393.11
Per cent of in-crease.....		9.2	17.2	13.6	45.6	88.4	.....	103.8	.....	95.6	.....	42.9	.....	100.8	.....
South Atlantic.....	1907	11,574,988	390	232	158	295,265	25.51	195,809	16.87	266,437,175	23,018.35	27,103	2.34	1,915,725	165.51
	1902	10,770,414	251	176	75	92,641	8.60	62,301	5.78	102,990,575	9,562.36	17,183	1.60	611,001	56.73
Per cent of in-crease.....		7.5	55.4	31.8	110.7	218.7	.....	213.5	.....	158.7	.....	57.7	.....	213.5	.....
North Central.....	1907	29,026,645	2,095	1,368	727	1,219,916	42.03	805,012	27.73	1,462,114,001	50,371.44	204,248	7.04	14,269,544	491.60
	1902	27,057,206	1,706	1,178	528	539,669	19.92	375,514	13.86	645,062,113	23,814.27	145,529	5.37	6,176,919	228.04
Per cent of in-crease.....		7.2	22.8	16.1	37.7	126.0	.....	114.4	.....	126.7	.....	40.3	.....	131.0	.....
South Central.....	1907	16,368,558	679	513	166	244,422	14.93	165,969	10.14	257,387,610	15,724.51	39,794	2.43	2,697,115	164.77
	1902	14,651,535	404	323	81	117,192	8.00	82,259	56.14	153,905,350	10,504.38	23,320	1.59	1,022,298	69.77
Per cent of in-crease.....		11.7	68.1	58.8	104.9	108.6	.....	101.8	.....	67.2	.....	70.6	.....	163.8	.....
Western.....	1907	4,783,557	480	429	51	803,999	168.08	488,407	102.10	1,393,231,724	291,254.34	42,248	8.83	5,376,139	1,123.88
	1902	4,289,085	346	318	28	280,818	65.47	174,612	40.71	335,762,076	78,282.91	30,112	7.02	1,822,621	424.94
Per cent of in-crease.....		11.5	38.7	34.9	82.1	186.3	.....	179.7	.....	315.0	.....	40.3	.....	195.0	.....

¹ Based upon Bureau of the Census estimates.

² Includes capacity of auxiliary engines, amounting to 65,823 horsepower in 1907 and 14,454 horsepower in 1902.

³ In 1907, exclusive of 162,338 lamps of "Other varieties—Nernst, vacuum, vapor, etc."—the revenue for which is included with the income for lighting, and 275,079 lamps used by the central stations to light their own electric properties. These lamps were not reported separately in 1902.

⁴ The number of incandescent lamps was largely an estimate and, although mostly reported on a 16-candlepower basis, embraces a considerable number ranging from 2 to 50 candlepower.

The comparison of the population of these geographic divisions with the several items of Table 7 representing the equipment and output of the stations may be roughly summarized as follows: The North Central, one-third of all items; the North Atlantic, one-fourth of the population and two-fifths of the other items; the South Atlantic and South Central combined, one-third of the population and one-eighth of the other items; and the Western, one-twentieth of the population and one-sixth of the other items. Comparing the proportion of population with that for the number of stations, the proportion of stations was larger than that for population for the North Central and Western divisions, and smaller for the North Atlantic, South Atlantic, and South Central divisions.

One of the most pronounced features of the central-station industry is the large per capita showing for the Western division, the output of stations and all the items of equipment, except arc lamps, being the largest of any group. The Western division, having, in 1907, less than 5,000,000 population, as compared with a population of upward of 11,000,000 and 16,000,000 for the South Atlantic and South Central divisions, respectively, reported a greater primary horsepower, a larger dynamo capacity, and more incandescent lamps wired for service than the two latter divisions combined. In per capita showing, the North Atlantic division was second in rank, the North Central third, the South Atlantic fourth, and the South Central fifth.

Mention has already been made of the fact that numerous tables in the report for 1902 contained statistics for the central stations, grouped according

to the population of the places in which the stations were located. Such a presentation of the statistics is interesting, but the following points should be considered in connection with the results:

1. The reports for the central stations are assigned to the places in which the plants are located.
2. The development of the alternating current by means of the single-phase or polyphase dynamo, referred to in the report of 1902, has continued since that census, until at the census of 1907 the kilowatt capacity of this class of machines represented 82 per cent of the total dynamo capacity of all central stations. In many instances large plants are now located at places where water power is available for the generation of the current, but at great distances from the places where the current is used. It is evident that any attempt to arrive at the true per capita consumption of current, and other features based on population by localities, should include the statistics for these generating plants, but this is impossible, since they frequently furnish current to two or more widely separated cities, mills, or factories. The following are among the most notable examples of this phase of the development and use of electrical energy: In California two companies have plants located in several small places where water power is available for the generation of electricity, which is not only transmitted to the largest cities in the state but is used in numerous smaller places in the course of its transit. In New York the electrical energy generated at Niagara Falls is distributed to various cities and towns in the state. In South Carolina there is one large company with generating plants at places where there

is water power, from which places the electrical energy is transmitted to various sections of that state. If necessary, many other instances of this character of electric service might be given, but these are deemed sufficient for the purpose.

3. Some electric companies, though owning two or more central stations situated in widely separated places, made but one report covering all of their properties. As a rule, such reports are assigned to the place in which the principal plant is located. In some instances these plants are in two or more of the groups of cities for which separate statistics were shown in 1902, and the assignment of all of them to a certain city or group of cities would detract from the value of conclusions based upon population.

A majority of the central stations, however, are located in the cities to which they are assigned and where all of their output, or the major portion, is consumed. While, therefore, this grouping of the stations in 1902 by population may have been instructive to some extent, the defects are too great, so far as relates to the commercial stations, to warrant such an analysis at the census of 1907. Statistics are presented, however, for the following 34 selected cities, grouped in four classes according to size:

Thirty-four selected cities grouped in four classes according to their estimated population in 1902.

500,000 and over.	100,000 but under 500,000.	25,000 but under 100,000.	5,000 but under 25,000.
Chicago, Ill. New York, N. Y. Philadelphia, Pa. St. Louis, Mo.	Cincinnati, Ohio. Cleveland, Ohio. Denver, Colo. Indianapolis, Ind. Louisville, Ky. Minneapolis, Minn. New Orleans, La. St. Paul, Minn. Washington, D. C. Worcester, Mass.	Dayton, Ohio. Des Moines, Iowa. Duluth, Minn. Erie, Pa. Evansville, Ind. Holyoke, Mass. Mobile, Ala. Reading, Pa. San Antonio, Tex. Wilmington, Del.	Anderson, Ind. Cumberland, Md. Flint, Mich. Hannibal, Mo. Lewiston, Me. Northampton, Mass. Oklahoma City, Okla. Paducah, Ky. Richmond, Ind. Shreveport, La.

In the selection of these 34 cities, the rule followed was to limit them to those in which all the electrical energy used was practically generated within their respective limits and but little, if any, sold for outside consumption. Although the selection was to some extent an arbitrary one, the cities are fairly representative of the various sections of the country. These 34 cities contained 75 stations in 1907 and 70 stations in 1902, the character of ownership of which in 1907 was as follows: Corporate, 61; and municipal, 14. In 1902, 58 were corporate; 11, municipal; and 1, individual.

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TABLE 8.—CENTRAL ELECTRIC STATIONS IN 34 SELECTED CITIES, BY GROUPS, ACCORDING TO POPULATION: 1907 AND 1902.

[The cities are grouped according to their estimated population in 1902, in order that the groups for the two census years may be identical.]

	THIRTY-FOUR CITIES.			FOUR CITIES, EACH HAVING A POPULATION OF 500,000 AND OVER.		
	1907	1902	Per cent of increase.	1907	1902	Per cent of increase.
Population ¹	12,088,994	10,546,858	14.6	8,461,375	7,381,580	14.6
Number of stations.....	75	70	7.1	24	22	9.1
Stock outstanding.....	\$186,133,534	\$136,115,950	36.7	\$132,800,984	\$105,086,650	26.4
Dividends.....	\$7,017,001	\$1,857,305	277.8	\$5,232,927	\$1,033,534	406.3
Bonds outstanding.....	\$181,078,998	\$108,571,502	66.8	\$135,130,386	\$93,030,502	45.3
Cost of construction and equipment.....	\$338,870,083	\$133,825,427	153.2	\$240,009,024	\$91,212,353	163.1
Gross income.....	\$53,242,154	\$25,120,735	111.9	\$38,868,287	\$18,087,346	114.9
Electric service.....	\$52,039,498	\$24,968,991	108.4	\$37,922,680	\$18,073,643	109.8
Lighting.....	\$39,583,359	\$20,833,882	90.0	\$28,409,863	\$15,051,352	88.8
Stationary motors.....	\$9,397,205	\$3,919,455	139.8	\$6,894,775	\$2,958,604	133.0
All other.....	\$3,058,934	\$215,054	1,318.4	\$2,618,042	\$33,687	4,010.8
All other sources.....	\$1,202,656	\$157,744	662.4	\$945,007	\$13,703	6,800.7
Total expenses.....	\$29,753,204	\$15,282,933	94.7	\$20,485,942	\$10,755,734	90.5
Cost of supplies and materials.....	\$3,784,641	\$2,952,346	28.2	\$2,337,290	\$2,181,129	7.2
Cost of fuel.....	\$5,527,510	\$2,493,049	121.7	\$3,047,844	\$1,650,792	120.2
Power purchased.....	\$1,121,079	\$213,929	424.0	\$668,281	\$15,700	4,156.6
Miscellaneous expenses.....	\$10,130,039	\$4,184,971	142.1	\$7,240,844	\$2,916,276	148.5
Salaries and wages.....	\$9,189,935	\$5,438,638	69.0	\$6,585,083	\$3,985,837	65.2
Salaried officials, clerks, etc.: Number.....	2,568	1,219	110.7	1,895	849	123.2
Salaries.....	\$2,851,745	\$1,291,172	120.9	\$2,104,888	\$924,128	127.8
Wage-earners: Average number.....	9,000	5,727	57.2	6,092	4,071	49.6
Wages.....	\$6,338,190	\$4,147,406	52.8	\$4,480,795	\$3,061,709	46.3
Primary power: ² Number of machines.....	585	485	20.6	276	234	17.9
Horsepower capacity.....	908,776	338,461	168.5	578,120	212,990	171.4
Generating equipment: Number of dynamos.....	979	1,584	238.2	460	925	250.3
Kilowatt capacity.....	639,195	218,688	192.3	415,079	133,247	212.2
Output of stations, kilowatt hours.....	1,337,608,288	479,132,378	179.2	989,516,589	303,435,153	226.1
Lamps wired for service: ⁴ Arc.....	183,731	111,437	64.9	120,169	70,376	70.8
Incandescent ⁵	11,522,603	5,484,938	110.1	7,833,661	4,069,473	92.5
Other varieties—Nernst, vacuum, vapor, etc.....	56,391	(⁶)	.....	40,779	(⁶)	.....

	TEN CITIES, EACH HAVING A POPULATION OF 100,000 BUT UNDER 500,000.			TEN CITIES, EACH HAVING A POPULATION OF 25,000 BUT UNDER 100,000.			TEN CITIES, EACH HAVING A POPULATION OF 5,000 BUT UNDER 25,000.		
	1907	1902	Per cent of increase.	1907	1902	Per cent of increase.	1907	1902	Per cent of increase.
Population ¹	2,693,310	2,354,704	14.4	719,613	632,582	13.8	214,096	177,992	20.6
Number of stations.....	23	24	24.2	15	12	25.0	13	12	8.3
Stock outstanding.....	\$37,739,390	\$26,490,600	42.5	\$13,105,760	\$3,855,000	240.0	\$2,427,400	\$683,700	255.0
Dividends.....	\$1,471,099	\$700,775	107.3	\$253,200	\$100,300	138.2	\$59,775	\$7,696	676.7
Bonds outstanding.....	\$27,490,900	\$12,058,500	128.0	\$15,208,712	\$2,884,000	427.3	\$3,249,000	\$598,500	442.9
Cost of construction and equipment.....	\$69,756,748	\$34,512,803	102.1	\$24,296,933	\$7,007,488	246.7	\$4,807,378	\$1,092,783	339.9
Gross income.....	\$10,676,631	\$5,236,059	103.9	\$2,739,816	\$1,436,751	90.7	\$957,420	\$366,579	161.2
Electric service.....	\$10,520,506	\$5,155,661	104.1	\$2,678,781	\$1,376,328	94.6	\$917,531	\$363,359	152.5
Lighting.....	\$8,360,722	\$4,236,520	97.3	\$2,078,740	\$1,214,083	71.1	\$734,034	\$331,327	121.5
Stationary motors.....	\$1,964,718	\$783,567	150.7	\$417,766	\$151,013	176.6	\$119,946	\$26,271	356.6
All other.....	\$195,066	\$135,574	43.9	\$182,275	\$10,632	1,614.4	\$63,551	\$5,761	1,000.3
All other sources.....	\$156,125	\$80,398	94.2	\$61,035	\$60,423	1.0	\$39,889	\$3,220	1,138.8
Total expenses.....	\$6,836,562	\$3,355,435	103.7	\$1,820,351	\$935,969	94.5	\$610,349	\$235,795	158.8
Cost of supplies and materials.....	\$1,101,472	\$554,705	98.6	\$284,886	\$180,875	57.5	\$60,993	\$35,637	71.2
Cost of fuel.....	\$1,237,747	\$627,804	97.2	\$447,154	\$141,820	215.3	\$194,765	\$66,633	192.3
Power purchased.....	\$229,526	\$106,990	114.5	\$219,525	\$91,239	140.6	\$3,747	.....	.....
Miscellaneous expenses.....	\$2,346,609	\$995,084	135.8	\$378,083	\$235,083	60.8	\$158,503	\$38,528	311.4
Salaries and wages.....	\$1,921,208	\$1,070,852	79.4	\$490,703	\$286,952	71.0	\$192,341	\$94,997	102.5
Salaried officials, clerks, etc.: Number.....	433	255	69.8	171	76	125.0	60	39	76.9
Salaries.....	\$523,803	\$252,702	107.3	\$160,116	\$84,407	89.7	\$62,848	\$29,935	109.9
Wage-earners: Average number.....	2,163	1,255	72.4	544	292	86.3	201	109	84.4
Wages.....	\$1,397,315	\$818,150	70.8	\$330,587	\$202,545	63.2	\$129,493	\$65,062	99.0
Primary power: ² Number of machines.....	174	153	13.7	94	62	51.6	41	36	13.9
Horsepower capacity.....	218,178	91,916	126.5	93,982	24,650	281.3	18,496	8,905	107.7
Generating equipment: Number of dynamos.....	292	432	232.4	160	150	6.7	67	77	212.0
Kilowatt capacity.....	147,439	64,147	129.8	62,603	10,210	286.2	13,174	5,084	159.1
Output of stations, kilowatt hours.....	249,286,502	119,533,836	108.5	73,547,040	35,156,654	109.2	25,257,557	21,006,735	20.2
Lamps wired for service: ⁴ Arc.....	47,308	30,792	53.6	11,958	7,431	60.9	4,296	2,838	51.4
Incandescent ⁵	2,769,920	1,112,946	148.9	703,211	231,114	204.3	215,811	71,405	202.2
Other varieties—Nernst, vacuum, vapor, etc.....	5,083	(⁶)	.....	10,211	(⁶)	.....	318	(⁶)	.....

¹Based upon Bureau of the Census estimates.
²Decrease.
³Exclusive of auxiliary engines with a total capacity of 10,659 horsepower in 1907 and 3,562 horsepower in 1902.
⁴Exclusive of 52,020 lamps used by the central stations to light their own electric properties in 1907. These lamps were not reported separately in 1902.
⁵The number of incandescent lamps was largely an estimate and, although mostly reported on a 16-candlepower basis, embraces a considerable number ranging from 2 to 50 candlepower.
⁶Not reported separately.

While the principal income of central stations is derived from lighting and stationary-motor service, electricity is being used for a constantly increasing variety of purposes. The income as reported from these miscellaneous uses is shown in Table 8 as "All other" under "Electric service." The several items composing this total are shown in Table 9.

TABLE 9.—Central electric stations in 34 selected cities—Income from "All other electric service," 1907 and 1902.

	1907	1902	Per cent of increase.
Total.....	\$3,058,934	\$215,654	1,318.4
Electric-railway service.....	1,960,551	138,275	1,317.9
Sales to other electric companies.....	779,728		
Heating, cooking, welding, etc.....	117,500	23,451	401.3
Charging automobiles.....	135,121	24,775	445.4
Miscellaneous electric service.....	65,974	29,153	126.3

More than nine-tenths of the gain in "Other electric service" was from the sale of current to electric-railway companies and to other companies engaged in the sale and distribution of current. The percentages of increase for the remaining items are large, but the actual amounts of income involved are comparatively small. The greater part of the income from "Miscellaneous electric service" was derived from the use of current to operate electric fans.

Although not shown in Table 8, certain facts connected with the generating plants in the 34 cities are briefly summarized, as follows: In 1907 nearly one-fourth of the primary power for the 4,714 central stations in the United States was connected with the 75 stations in these selected cities. The proportion of steam power in the total primary power in these cities was 92.5 per cent in 1907 and 98.7 per cent in 1902, as compared with 65.2 per cent and 75.4 per cent, respectively, for the United States. As illustrative of the extensive use of the steam turbine in the more thickly settled communities, 55.6 per cent of the total horsepower reported for steam turbines in the central stations in the United States was reported by the stations in these 34 selected cities. Chicago claims the distinction of having the largest prime mover in the world, a steam turbine of 22,000 horsepower, several more of which are about to be installed in the same station. The gas engine was very little used in these cities, only 4 engines with a total of 60 horsepower being reported in 1907, all in the group of cities of over 500,000 population. In 1902 the group of cities "5,000 but under 25,000" was the only one not reporting gas engines, although but 300 horsepower of this character was reported for the 34 cities, which formed only one-tenth of 1 per cent of the total for all kinds of primary power. A considerable increase in water power is shown, from 1.2 per cent in 1902 to 7.6 per cent in 1907. No water power was reported in the 4 cities of over 500,000 population, but it is shown for each of the remaining groups. The increase in water

power was not due to the general adoption of this form of primary power, as nearly nine-tenths of the total increase was confined to two companies, one in the group of cities of 100,000 but under 500,000 population, where the water power increased from 2,400 horsepower in 1902 to 19,600 horsepower in 1907, and the other in the group of cities of 25,000 but under 100,000 population, in which there has been installed since 1902 a plant reporting water wheels of 39,700 horsepower. Although this latter plant was reported in 1907, it had been in operation but a few months and at only a fraction of the capacity reported.

Exclusive of the horsepower of the gas engines, which was comparatively insignificant, the horsepower capacity reported by all central stations in the United States in 1907 was about two-thirds steam and one-third water. In 1902 the proportions were about three-fourths steam and one-fourth water. For the 34 cities in 1907 more than nine-tenths was steam and less than one-tenth water, while in 1902 practically all the primary power was steam.

The generating equipment for the 34 selected cities, which is reported in bulk in Table 8, is shown in detail in Table 10.

TABLE 10.—Central electric stations in 34 selected cities—Generating equipment: 1907 and 1902.

KIND OF DYNAMO.	Census.	Thirty-four cities.	Four cities, each having a population of 500,000 and over.	Ten cities, each having a population of 100,000 but under 500,000.	Ten cities, each having a population of 25,000 but under 100,000.	Ten cities, each having a population of 5,000 but under 25,000.
Number of stations.....	1907 1902	75 70	24 22	23 24	15 12	13 12
Dynamos: Number.....	1907 1902	979 1,584	460 925	202 432	160 150	67 77
Kilowatt capacity.....	1907 1902	630,195 218,688	415,979 133,247	147,439 64,147	62,603 16,210	13,174 5,084
Direct-current, constant-voltage: Number.....	1907 1902	312 432	125 192	96 150	70 64	21 26
Kilowatt capacity.....	1907 1902	95,956 94,552	38,984 50,927	40,275 34,943	13,798 7,207	2,899 1,475
Direct-current, constant-amperage: Number.....	1907 1902	385 702	218 401	109 210	41 60	17 31
Kilowatt capacity.....	1907 1902	23,748 37,222	15,505 22,287	5,579 11,214	2,069 2,703	595 1,018
Alternating single-phase and polyphase current: Number.....	1907 1902	282 450	117 332	87 72	49 26	29 20
Kilowatt capacity.....	1907 1902	519,491 86,914	361,490 60,033	101,585 17,990	46,736 6,300	9,680 2,591

The kilowatt capacity of the dynamos in the 34 selected cities formed about the same proportion of the total for the United States, slightly less than one-fourth, as did the primary power. The percentage of increase, however, was considerably larger for the 34 cities than for the United States. The kilowatt

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capacity of the direct-current, constant-voltage dynamos, which increased 23.1 per cent in the United States, practically remained stationary in the total for the 34 cities, the increase being less than 2 per cent. An actual loss is shown for the 4 cities of largest population, which, however, is slightly overcome by gains in each of the other three groups. The capacity of the direct-current, constant-amperage dynamo decreased in each of the several groups of cities, in harmony with the decrease shown for this class of dynamo in the total for the United States. The capacity of the alternating single-phase and polyphase current dynamo increased in each group, and the percentage of gain for the 34 cities together was much greater than that for the country as a whole.

Notwithstanding the gain in kilowatt capacity of the dynamos there was a general decrease in their number, which fact harmonizes with the conclusions in the chapter treating of the generating equipment of all central stations, where the average capacity of

the dynamos in 1907 is shown to be much larger than was reported in 1902.

Large and small stations.—As previously explained, the classification of "central station" is based on the character of the service and not on the size of the plant. No limit was placed on the size of the plants to be enumerated, and although there are some very large stations, the vast majority are comparatively small. The commercial stations range from the one located at Stanton, Iowa, with gas as the primary power and a dynamo of 3-kilowatt capacity, to one in New York City having steam as the primary power and a total dynamo capacity of 149,300 kilowatts. The municipal stations range from the one located at Bath, Ill., also with gas as the primary power and a dynamo capacity of 6 kilowatts, to that located at Chicago, with steam as the primary power and a total dynamo capacity of 5,473 kilowatts. Table 11 classifies the stations according to dynamo capacity.

TABLE 11.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—NUMBER, BY DYNAMO CAPACITY OF STATIONS: 1907 AND 1902.

DYNAMO CAPACITY OF STATION.	TOTAL.		COMMERCIAL.		MUNICIPAL.		PER CENT DISTRIBUTION.					
	1907	1902	1907	1902	1907	1902	Total.		Commercial.		Municipal.	
							1907	1902	1907	1902	1907	1902
Total.....	4,714	3,620	3,462	2,805	1,252	815	100.0	100.0	100.0	100.0	100.0	100.0
Under 200 kilowatts.....	3,038	2,587	2,116	1,890	922	697	64.4	71.5	61.1	67.4	73.6	85.5
200 but under 500 kilowatts.....	821	586	584	497	237	89	17.4	16.2	16.9	17.7	18.9	10.9
500 but under 1,000 kilowatts.....	269	172	225	100	44	12	5.7	4.8	6.5	5.7	3.5	1.5
1,000 but under 2,000 kilowatts.....	169	98	159	92	10	6	3.6	2.7	4.6	3.3	0.8	0.7
2,000 but under 5,000 kilowatts.....	115	66	111	64	4	2	2.4	1.8	3.2	2.3	0.3	0.2
5,000 kilowatts and over.....	75	33	74	32	1	1	1.6	0.9	2.1	1.1	0.1	0.1
Stations having no generating equipment.....	227	78	193	70	34	8	4.8	2.2	5.6	2.5	2.7	1.0

The extent of the predominance of the small station is evident from the fact that 81.8 per cent of all stations in 1907 and 87.7 per cent in 1902 were under 500-kilowatt capacity, while considerably more than one-half of all, 64.4 per cent in 1907 and 71.5 per cent in 1902, were under 200-kilowatt capacity. As would be expected, the number of stations in the various classes grows proportionately less as the classes increase in dynamo capacity.

Of the commercial stations, 16.4 per cent in 1907 and 12.4 per cent in 1902 were embraced in the classes which had a kilowatt capacity of 500 horsepower or over, while of the municipal stations, only 4.7 per cent in 1907 and 2.5 per cent in 1902 reported this capacity. Although the percentages of increase are almost uniformly larger for the municipal stations, in but one class, that of "200 but under 500 kilowatts," was the actual increase the greater. The commercial stations made the only increase in the class of largest dynamo capacity, there being but one municipal

station of this class both in 1907 and 1902, which was located in Chicago. Except for a small amount of current sold to other electric companies, this plant was engaged exclusively in arc lighting.

The distribution, by dynamo capacity, of the purely electric and of the composite stations is shown in Table 12.

For all the stations supplied with dynamos the percentages of increase were uniformly greater for the composite stations. In this group the proportion of small stations, or those under 500-kilowatt capacity, was 83.8 per cent in 1907 and 89.8 per cent in 1902 as compared with 80.4 and 86.2 per cent, respectively, for the purely electric. Among the purely electric stations the larger plants are a little more numerous, relatively, than among the composite stations. It appears, however, that the manufacture of electric current on a large scale is combined with other lines of work almost as much as the manufacture of current on a small scale.

TABLE 12.—PURELY ELECTRIC AND COMPOSITE CENTRAL ELECTRIC STATIONS—NUMBER, BY DYNAMO CAPACITY OF STATIONS: 1907 AND 1902.

DYNAMO CAPACITY OF STATION.	TOTAL.		PURELY ELECTRIC.		COMPOSITE.		PER CENT DISTRIBUTION.					
							Total.		Purely electric.		Composite.	
	1907	1902	1907	1902	1907	1902	1907	1902	1907	1902	1907	1902
Total.....	4,714	3,620	2,648	2,139	2,066	1,481	100.0	100.0	100.0	100.0	100.0	100.0
Under 200 kilowatts.....	3,038	2,587	1,692	1,477	1,346	1,110	64.4	71.5	63.9	69.1	65.2	74.9
200 but under 500 kilowatts.....	821	586	436	366	436	220	17.4	16.2	16.5	17.1	18.6	14.9
500 but under 1,000 kilowatts.....	269	172	140	96	129	76	5.7	4.8	5.3	4.5	6.2	5.1
1,000 but under 2,000 kilowatts.....	169	98	80	69	89	29	3.6	2.7	3.0	3.2	4.3	2.0
2,000 but under 5,000 kilowatts.....	115	66	70	48	45	18	2.4	1.8	2.6	2.2	2.2	1.2
5,000 kilowatts and over.....	75	33	48	23	27	10	1.6	0.9	1.8	1.1	1.3	0.7
Stations having no generating equipment.....	227	78	182	60	45	18	4.8	2.2	6.9	2.8	2.2	1.2

The distribution of the stations by dynamo capacity is shown by geographic divisions in Table 13.

The Western division, although having in 1907 less than one-half the population of any of the other divisions, had more stations of 1,000-kilowatt capacity and over than either the South Atlantic or the South Central divisions, and in the largest class of 5,000 and over, nearly double the number for these two divisions combined. Another noticeable feature connected with the Western division is the relatively large number of stations not equipped with dynamos, being exceeded in this respect only by the North Atlantic division. In 1907, although not shown in Table 13, there were

4 states each of which had more than ten stations not possessing electric generators, as follows: California, 40; New York, 30; Pennsylvania, 30; and Massachusetts, 18. In 1902 such stations were reported by these states as follows: California, 25; New York, 4; Pennsylvania, 11; and Massachusetts, 5. These figures show that California had considerably the largest number of stations dependent upon other plants for their electrical energy, and this showing may be explained by the fact that in this state exceptionally long transmission lines are used, the electricity in one instance being generated upward of 200 miles from the places where it is chiefly used.

TABLE 13.—CENTRAL ELECTRIC STATIONS—NUMBER, BY DYNAMO CAPACITY AND BY GEOGRAPHIC DIVISIONS: 1907 AND 1902.

DIVISION.	TOTAL.		UNDER 200 KILOWATTS.		200 BUT UNDER 500 KILOWATTS.		500 BUT UNDER 1,000 KILOWATTS.		1,000 BUT UNDER 2,000 KILOWATTS.		2,000 BUT UNDER 5,000 KILOWATTS.		5,000 KILOWATTS. AND OVER.		STATIONS HAVING NO GENERATING EQUIPMENT.	
	1907	1902	1907	1902	1907	1902	1907	1902	1907	1902	1907	1902	1907	1902	1907	1902
	Total.....	4,714	3,620	3,038	2,587	821	586	269	172	169	98	115	66	75	33	227	78
North Atlantic.....	1,070	913	481	499	224	216	113	86	76	42	50	26	27	15	99	29
South Atlantic.....	390	251	250	201	90	35	11	4	10	2	8	6	7	1	14	2
North Central.....	2,095	1,706	1,527	1,347	346	241	95	60	47	25	27	19	20	6	33	8
South Central.....	679	404	530	328	98	48	20	11	11	10	12	4	3	1	5	2
Western.....	480	346	250	212	63	46	30	11	25	19	18	11	18	10	76	37

Consolidation of electric stations with other enterprises.—In 1907 an effort was made to ascertain the extent of the association of other industries with central electric stations, and the results are presented in the following statement:

Commercial and municipal central electric stations—Number and kind of associated enterprises: 1907.

	Total.	Commer- cial.	Municipal.
United States.....	4,714	3,462	1,252
Purely electric.....	2,648	2,127	521
Composite.....	2,066	1,335	731
Total associated enterprises.....	2,306	1,568	738
Waterworks.....	1,036	320	716
Gas plants ¹	329	317	12
Lumber and grist mills.....	310	307	3
Ice manufacture.....	212	212	
Steam heating.....	118	114	4
Cotton gins.....	35	35	
Electric railways.....	32	32	
Miscellaneous.....	234	231	3

¹ Manufactured gas.

Of the 4,714 central electric stations, the composite central stations, or those which were operated in connection with other industries, numbered 2,066. These stations were associated with 2,306 industries of various kinds, the excess of industries being due to the fact that a single central station may be associated with several other industries. The association of central stations with waterworks and gas plants is the most common, and for the municipal plants there was practically no other. For the commercial stations there were 995 operated in connection with such public service as waterworks, gas works, street railways, steam heating, and the manufacture of ice, and 573 stations operated in connection with some other business. The central stations associated with such industries as sawmills, gristmills, manufactured ice, and cotton gins, are likely to be of secondary importance, and owe their existence to the facility with which surplus primary power, by use of the

CENTRAL ELECTRIC LIGHT AND POWER STATIONS.

dynamo, may be converted into electrical energy and transmitted for service as light or power to near-by or remote points.

Of the various industries mentioned, the manu-

facture of illuminating gas comes into the most direct competition with the generation of electrical energy, and a comparative summary of the two industries is shown in Table 14.

TABLE 14.—COMPARATIVE SUMMARY—CENTRAL ELECTRIC STATIONS AND GAS PLANTS.

	CENTRAL ELECTRIC STATIONS.		GAS PLANTS.		PER CENT OF INCREASE.	
	1907	1902	1905	1900	Central electric stations.	Gas plants.
Number of establishments.....	4,714	3,620	1,019	877	30.2	16.2
Cost of construction and equipment.....	\$1,096,913,622	\$504,740,352	\$725,036,204	\$567,000,506	117.3	27.9
Gross income.....	\$175,642,338	\$85,700,605	\$125,144,945	\$75,716,693	104.9	65.3
From sale of electric current or gas.....	\$169,614,691	\$84,186,605	\$112,662,568	\$69,432,582	101.5	62.3
From all other sources.....	\$6,027,647	\$1,514,000	\$12,482,377	\$6,284,111	298.1	98.6
Cost of supplies, materials, power purchased, and fuel.....	\$44,458,568	\$22,915,932	\$37,180,066	\$20,605,356	94.0	80.4
Salaries officials, etc.:.....						
Number.....	12,990	6,996	9,406	5,904	85.7	59.3
Salaries.....	\$11,733,737	\$5,663,530	\$8,463,699	\$5,273,500	107.2	60.5
Wage-earners:.....						
Average number.....	34,642	23,330	30,566	22,459	48.5	36.1
Wages.....	\$23,686,537	\$14,983,112	\$17,057,917	\$12,430,296	58.1	37.2

¹Capital invested—owned and borrowed.

Although the statistics for the two industries in Table 14 do not cover the same years, they represent the results of two censuses taken at five-year intervals, the respective census years being sufficiently near together for purposes of general comparison. The respective costs of construction for the two industries are based upon too widely different constituents to warrant their use except as they show the comparative growth of each industry. This item for electric stations represents the total cost of plants and equipment, and that for the gas plants embraces the capital invested—owned and borrowed. The percentages of increase for the central stations are uniformly greater than for the gas plants, although those for the latter industry are surprisingly large considering the competition of the newer industry.

The item most comparable is that which represents the income from the sale of electrical energy in one industry and from the sale of gas in the other. The income represented by this item not only constitutes in each industry more than 90 per cent of the total from all sources, but the chief uses of the electricity and manufactured gas are for identical purposes. A comparison of this source of income shows an increase of 101.5 per cent for the central stations and 62.3 per cent for the gas plants. It is to be remembered that the census figures for central stations in Table 14 do not embrace all that properly belongs to the central-station industry, since electric-railway companies sell electric current, amounting in 1907 to upward of \$20,000,000 worth, and thousands of isolated private stations exist which were not included in the census. There are likewise many isolated private gas plants, but the number is believed to be insignificant compared with the isolated electric plants.

In 1907, 329 stations reported that they also operated gas plants, but this by no means represents the

extent to which the consolidation of the interests of the two industries has been carried, since it does not cover instances wherein the whole, or a controlling portion, of the stock of one industry has been acquired by the other, and the companies are operated under separate management regardless of stock ownership. There is a growing tendency to merge the two industries partly to avoid the sharp competition whenever they are common bidders for the same class of business.

MUNICIPAL PLANTS.

A comparison of the number of reports received from municipal stations in 1907 with the number received in 1902 shows an increase of 53.6 per cent as compared with 23.4 per cent for the commercial companies. The municipal stations are practically exempt from the consolidations that so frequently occur among commercial companies, and this fact no doubt accounts in large part for the proportionately greater increase in the former class of stations. Not only was there a large increase in the number of municipal stations, but an analysis of the reports shows that although 33 municipal stations which reported in 1902 had become commercial stations in 1907, 113 stations which were reported as commercial in 1902 had become municipal in 1907. The claim has been made, and sustained by what appears to be reasonable argument, that the drift of these public utilities is from municipal to commercial, but the results of the census do not furnish corroborative evidence of this. On the contrary there appears to be a distinct field for municipal electric stations, not only because of a feeling which may exist in many localities that these public utilities should be owned by the cities, but because many of the places in which municipal plants are located do not present sufficient inducement for the investment of commercial capital.

TABLE 15.—Municipal central electric stations—Number, with additions since 1902, by geographic divisions: 1907.

DIVISION.	Total reported in 1907.	Reported in 1902 and 1907.	Constructed since 1902.	Commercial in 1902 and municipal in 1907.	In operation in 1902 but not reported at that census.
Total.....	1,252	774	348	113	17
North Atlantic.....	150	100	39	9	2
South Atlantic.....	158	72	66	17	3
North Central.....	727	502	160	57	8
South Central.....	166	77	63	24	2
Western.....	51	23	20	6	2

The stability of these plants is exemplified by the fact that 774 of the 815 municipal plants reported in 1902 also reported in 1907. Of the 41 which failed to report in 1907, 33 had become commercial stations, as previously noted; 4 had discontinued operations or were idle; 2 were connected with public institutions, the plants of which were excluded from the census of 1907; 1 was merged with another municipal plant because of the consolidation of two cities since 1902; and 1 was destroyed by fire and had not been rebuilt at the time of taking the census of 1907.

Reasons have already been given for the omission of the statistics of central stations, classified by the population of the places in which the plants were located. The objections, which are pronounced for the commercial stations, are not, however, deemed sufficient to warrant the omission of general statistics for the municipal stations showing distribution by population grouping. The number of these stations in each geographic division by population groupings is presented in Table 16.

TABLE 16.—Municipal central electric stations—Number, by population of cities in which located and by geographic divisions: 1907 and 1902.

[The cities have been grouped according to their population in 1900.]

DIVISION.	Census.	Total.	NUMBER OF STATIONS IN CITIES HAVING A POPULATION OF—				
			Under 5,000.	5,000 but under 25,000.	25,000 but under 100,000.	100,000 but under 500,000.	500,000 and over.
Total.....	1907 1902	1,252 815	1,081 671	142 121	17 13	6 6	6 4
North Atlantic.....	1907 1902	150 103	107 68	38 31	3 2	1 2	1
South Atlantic.....	1907 1902	158 75	142 62	13 11	2 2	.....	1
North Central.....	1907 1902	727 528	636 449	76 67	6 4	5 4	4 4
South Central.....	1907 1902	166 81	152 68	10 9	4 4	.....	.....
Western.....	1907 1902	51 28	44 24	5 3	2 1	.....	.....

Table 16 shows that most of the municipal stations are in places of small population, nearly seven-eighths of the total number being located in places of less than 5,000 population and less than 3 per cent in places having a population of 25,000 and over. In the 3 divisions—the South Atlantic, the South Central, and the Western—together, only 1 station was reported in 1907 for cities of over 100,000 population, but it is to be remembered that in these 3 divisions together there were only 8 cities of this class according to the census of 1900. In the North Atlantic division there were 16 cities of this class, with only 2 municipal plants in 1907; and in the North Central, 14 cities, with 9 municipal plants. The 1 station reported for the South Atlantic division was in Baltimore, while the 4 stations in the “500,000 and over” class in 1907 and 1902 in the North Central division were all located in Chicago.

Table 17 gives detailed statistics of municipal stations, classified according to population of places in which located.

Although, as already noticed, the group of smallest population embraced seven-eighths of the total number of municipal stations, their proportion of other leading items in the table was smaller, varying from about one-half to two-thirds, except for the number of arc lamps, for which the proportion was only about three-eighths. Nearly one-eighth of the total number of stations were found in the next higher group, “5,000 but under 25,000,” and these stations reported about one-fourth of the totals for the several chief items. For the remaining three groups, the various items of finance, equipment, and output were naturally much out of proportion to the number of stations. For the group “25,000 but under 100,000,” the leading items averaged roughly 9 per cent of their several totals, and for each of the two groups embracing the cities of largest population, 5 or 6 per cent. In the stations of the cities of largest population the high proportion of arc lamps as compared with incandescent lamps is noteworthy, and clearly indicates the character of the service of the few stations in the large cities.

The North Central division reported considerably more than one-half of the total number of municipal stations and the same proportion of all the other chief items in Table 17. The North Atlantic division stood second. The figures for the stations in the South Central and South Atlantic divisions are about equal as a whole, and those for the Western division the smallest in every respect, except for incandescent and for “Other varieties” of lamps.

CENTRAL ELECTRIC LIGHT AND POWER STATIONS.

TABLE 17.—MUNICIPAL CENTRAL ELECTRIC STATIONS, BY POPULATION OF CITIES

[The cities have been grouped

DIVISION AND POPULATION GROUP.		Census.	Number of stations.	Cost of construction and equipment.	INCOME.		
					Total.	Electric service.	All other sources.
1	Total	1907	1,252	\$42,879,447	\$14,011,999	\$13,614,434	\$397,565
2		1902	815	22,020,473	6,965,105	6,836,850	128,249
3	Under 5,000.....	1907	1,081	21,476,667	7,631,842	7,337,260	204,582
4		1902	671	11,074,008	3,621,023	3,538,498	82,555
5	5,000 but under 25,000.....	1907	142	9,726,310	3,466,142	3,389,192	76,950
6		1902	121	5,605,178	1,765,000	1,732,897	32,103
7	25,000 but under 100,000.....	1907	17	4,823,933	1,414,810	1,408,521	6,289
8		1902	13	1,553,931	455,204	455,149	55
9	100,000 but under 500,000.....	1907	6	2,760,732	736,276	716,532	19,744
10		1902	6	1,607,803	441,235	427,899	13,536
11	500,000 and over.....	1907	6	4,092,705	762,929	762,929	.....
12		1902	4	2,179,553	682,643	682,643	.....
13	North Atlantic.....	1907	150	7,838,995	2,308,082	2,266,506	41,576
14		1902	103	3,942,139	1,089,531	1,075,283	14,248
15	Under 5,000.....	1907	107	3,088,388	872,150	845,774	26,376
16		1902	68	1,697,447	392,586	384,109	8,477
17	5,000 but under 25,000.....	1907	38	3,025,195	897,546	882,346	15,200
18		1902	31	1,510,923	424,886	419,115	5,771
19	25,000 but under 100,000 ²	1907	5	1,725,412	538,386	538,386	.....
20		1902	4	733,769	272,059	272,059	.....
21	South Atlantic.....	1907	158	4,076,042	1,621,309	1,574,043	47,266
22		1902	75	1,561,938	583,162	577,479	5,683
23	Under 5,000.....	1907	142	2,973,002	1,072,023	1,027,220	44,803
24		1902	62	920,726	333,335	328,776	4,559
25	5,000 but under 25,000 ³	1907	13	476,510	230,343	227,880	2,463
26		1902	13	641,212	249,827	248,703	1,124
27	25,000 but under 100,000 ⁴	1907	3	626,530	318,943	318,943	.....
28	North Central.....	1907	727	22,955,162	7,403,015	7,142,752	260,263
29		1902	528	13,872,245	4,397,599	4,308,879	88,630
30	Under 5,000.....	1907	636	11,306,559	4,178,706	3,992,505	186,201
31		1902	449	7,151,667	2,396,828	2,338,038	58,790
32	5,000 but under 25,000.....	1907	76	4,823,705	1,829,198	1,775,195	54,003
33		1902	67	3,145,901	1,009,166	992,917	16,249
34	25,000 but under 100,000.....	1907	6	665,888	200,438	200,123	315
35		1902	4	302,811	87,817	87,762	55
36	100,000 but under 500,000.....	1907	5	2,177,490	472,801	453,057	19,744
37		1902	4	1,092,313	221,055	207,519	13,536
38	500,000 and over.....	1907	4	3,976,520	721,872	721,872	.....
39		1902	4	2,179,553	682,643	682,643	.....
40	South Central.....	1907	166	4,259,121	1,640,608	1,609,032	31,576
41		1902	31	1,582,386	566,146	554,208	11,938
42	Under 5,000.....	1907	152	3,046,244	1,133,925	1,104,549	29,376
43		1902	68	929,481	394,251	354,350	9,901
44	5,000 but under 25,000.....	1907	10	705,552	321,549	319,349	2,200
45		1902	9	364,730	142,742	140,705	2,037
46	25,000 but under 100,000.....	1907	4	507,325	185,134	185,134	.....
47		1902	4	288,175	59,153	59,153	.....
48	Western.....	1907	51	3,750,127	1,038,985	1,022,101	16,884
49		1902	28	1,061,765	328,757	321,007	7,750
50	Under 5,000.....	1907	44	1,062,474	375,038	367,212	7,826
51		1902	24	374,687	134,023	133,195	828
52	5,000 but under 25,000 ⁵	1907	7	2,687,653	663,947	654,889	9,058
53		1902	4	687,078	194,734	187,812	6,922

¹ Not reported separately in 1902.² Includes 1 station of the "100,000 but under 500,000" group and 1 station of the "500,000 and over" group in 1907, and 2 stations of the former group in 1902, in order that the operations of individual stations may not be disclosed.

SUMMARY OF STATISTICS.

IN WHICH LOCATED AND BY GEOGRAPHIC DIVISIONS: 1907 AND 1902.

according to their population in 1900.]

Total expenses.	Primary-power plant, total horsepower.	KILOWATT CAPACITY OF DYNAMOS.				Output of stations, kilowatt hours.	LAMPS WIRED FOR SERVICE.			
		Total.	Direct current.		Alternating single-phase and polyphase current.		Arc.	Incandescent.	Other varieties—Nernst, vacuum, vapor, etc. ¹	
			Constant voltage.	Constant amperage.						
\$0,167,188 4,741,182	321,351 160,028	209,016 113,380	26,754 17,556	19,239 28,171	163,023 67,653	289,462,788 195,904,439	82,940 50,795	4,052,448 1,577,451	8,870	1 2
5,298,119 2,620,167	194,172 96,282	130,174 64,650	22,179 13,450	5,176 7,229	102,819 43,971	146,906,359 105,518,293	30,888 19,611	2,719,249 1,094,946	3,270	3 4
2,128,859 1,212,636	75,975 40,123	48,107 28,966	2,813 2,867	4,895 7,625	40,399 18,474	78,788,119 56,286,059	23,033 15,701	952,967 391,645	1,565	5 6
778,358 315,139	25,763 7,713	14,812 5,394	942 927	2,465 1,892	11,405 2,575	29,815,562 8,929,900	9,549 4,800	325,548 66,840	3,738	7 8
373,750 255,606	12,616 6,085	8,250 4,263	350 107	1,890 2,762	6,010 1,394	17,819,478 9,543,807	8,393 4,644	42,754 21,620	282	9 10
588,102 337,634	12,825 9,825	7,673 10,107	470 205	4,813 8,663	2,390 1,239	16,133,270 15,626,380	11,077 0,139	11,930 2,400	15	11 12
1,406,815 768,363	56,580 26,657	35,325 17,885	2,133 1,334	3,370 4,225	29,822 12,326	48,861,638 28,469,646	12,320 7,846	703,634 272,212	1,149	13 14
567,090 294,739	24,240 13,907	16,103 8,528	771 660	905 954	14,427 6,914	17,742,732 12,624,636	3,546 2,387	397,819 151,985	446	15 16
571,386 318,692	21,049 9,615	12,892 6,917	950 551	1,247 1,566	10,695 4,800	19,182,675 10,983,988	5,345 3,464	254,749 104,902	590	17 18
268,339 154,922	11,261 3,075	6,330 2,440	412 123	1,218 1,705	4,700 612	11,936,231 4,861,022	3,429 1,995	51,066 15,325	113	19 20
1,051,002 385,412	36,542 12,410	22,759 8,469	2,138 1,171	1,482 1,672	19,139 5,626	30,300,397 17,072,971	7,529 4,230	402,953 107,704	63	21 22
723,425 240,438	25,119 8,070	17,349 5,215	1,543 798	232 574	15,574 6,914	18,283,131 10,349,782	4,650 2,010	294,643 68,843	40	23 24
137,415 144,974	4,950 4,340	3,183 3,254	..... 373	568 1,098	2,615 1,783	4,563,870 6,723,189	1,715 2,220	43,880 38,921	23	25 26
187,762	6,473	2,227	595	682	950	7,453,396	1,164	64,430	.....	27
5,072,384 2,938,805	176,221 102,895	115,990 73,169	19,240 12,578	13,477 20,704	83,273 39,887	159,005,189 127,865,521	52,327 33,595	2,204,135 1,014,120	3,609	28 29
2,999,451 1,736,342	110,320 62,994	73,973 42,472	16,885 9,740	3,979 5,294	53,109 27,438	81,282,275 68,683,634	18,351 13,314	1,625,908 770,658	2,360	30 31
1,127,782 658,289	40,166 24,123	26,042 16,843	1,705 2,005	2,678 4,970	21,659 9,862	43,628,086 35,277,472	13,544 9,699	521,401 226,772	945	32 33
136,983 61,575	3,875 1,778	2,735 989	300 583	1,080 182	1,355 224	5,521,786 2,545,510	2,755 1,349	16,565 1,100	7	34 35
260,168 144,965	9,720 4,175	6,037 2,758	350 45	927 1,588	4,760 1,125	13,487,582 5,732,525	6,801 3,094	32,661 13,190	282	36 37
547,997 337,634	12,140 9,825	7,203 10,107	..... 205	4,813 8,664	2,390 1,238	15,105,460 15,626,380	10,876 6,139	7,600 2,400	15	38 39
1,070,069 403,246	33,440 14,548	25,133 10,393	2,997 1,402	843 1,302	21,293 7,629	34,365,978 17,484,135	7,188 3,640	353,646 108,521	187	40 41
788,196 231,938	27,510 8,908	18,415 5,862	2,734 1,186	38 299	15,643 4,377	23,272,378 10,517,220	3,578 1,552	286,134 78,623	187	42 43
182,060 103,559	5,625 3,320	3,815 2,753	158 82	357 612	3,300 2,089	6,861,650 5,233,720	1,680 1,054	63,388 27,365	.....	44 45
99,813 37,749	3,305 2,320	2,903 1,748	105 134	448 451	2,350 1,163	4,231,960 1,733,195	1,930 1,034	4,124 2,533	.....	46 47
506,318 245,366	15,568 3,518	9,809 3,434	246 1,071	67 208	9,496 2,185	16,929,586 5,012,166	3,576 1,484	388,080 74,834	3,862	48 49
216,957 83,710	6,983 2,343	4,334 2,573	246 1,036	22 108	4,056 1,399	6,345,853 3,343,021	703 348	114,745 24,837	237	50 51
349,361 158,656	8,585 1,175	5,475 831	..... 5	45 100	5,430 786	10,583,733 1,669,145	2,813 1,136	273,335 49,997	3,625	52 53

³ Includes 2 stations of the "25,000 but under 100,000" group in 1902.

⁴ Includes 1 station of the "500,000 and over" group in 1907.

⁵ Includes 2 stations of the "25,000 but under 100,000" group in 1907, and 1 station of this group in 1902.

CENTRAL ELECTRIC LIGHT AND POWER STATIONS.

Nearly nine-tenths of the municipal stations are located in places for which they supply the entire electric current used, and the statistics for these stations, by geographic divisions, are presented in Table 18.

TABLE 18.—MUNICIPAL CENTRAL ELECTRIC STATIONS WHICH SUPPLY THE ENTIRE ELECTRIC SERVICE IN THE CITIES WHERE LOCATED, BY GEOGRAPHIC DIVISIONS: 1907 AND 1902.

	Census.	Total.	DIVISION.				
			North Atlantic.	South Atlantic.	North Central.	South Central.	Western.
Number of stations.....	1907 1902	1,114 732	123 93	143 65	658 476	152 72	38 26
Cost of construction and equipment.....	1907 1902	\$27,310,126 \$15,369,382	\$5,250,104 \$9,121,983	\$3,602,972 \$1,043,002	\$14,117,089 \$8,963,636	\$3,485,495 \$1,203,393	\$844,806 \$1,037,368
Gross income.....	1907 1902	\$9,762,111 \$4,923,196	\$1,452,700 \$770,903	\$1,396,523 \$372,983	\$5,273,998 \$2,985,836	\$1,369,437 \$473,597	\$209,453 \$319,877
Electric service.....	1907 1902	\$9,419,223 \$4,814,568	\$1,416,548 \$750,655	\$1,354,603 \$367,300	\$5,047,744 \$2,916,827	\$1,338,200 \$461,659	\$262,128 \$312,127
Lighting.....	1907 1902	\$9,026,172 \$4,741,735	\$1,331,363 \$741,502	\$1,305,739 \$366,639	\$4,876,268 \$2,889,183	\$1,274,062 \$450,177	\$238,740 \$294,234
Commercial.....	1907 1902	\$6,204,396 \$2,925,788	\$805,934 \$389,206	\$906,681 \$199,029	\$3,371,141 \$1,827,478	\$929,799 \$304,800	\$190,841 \$205,215
Public.....	1907 1902	\$2,821,776 \$1,815,947	\$525,429 \$352,296	\$399,058 \$167,610	\$1,505,127 \$1,061,705	\$344,263 \$145,317	\$47,899 \$89,019
Stationary motors.....	1907 1902	\$342,865 \$63,880	\$79,634 \$12,638	\$45,128 \$661	\$151,706 \$24,098	\$45,481 \$11,082	\$20,916 \$15,401
All other.....	1907 1902	\$50,186 \$8,953	\$5,551 \$2,515	\$3,736	\$19,770 \$3,546	\$18,657 \$400	\$2,472 \$2,492
All other sources.....	1907 1902	\$342,888 \$108,628	\$36,152 \$14,248	\$41,020 \$5,683	\$226,254 \$69,000	\$31,237 \$11,938	\$7,325 \$7,750
Total expenses.....	1907 1902	\$6,573,242 \$3,567,352	\$930,274 \$595,586	\$890,831 \$267,091	\$3,674,883 \$2,120,088	\$909,922 \$342,275	\$167,332 \$242,312
Cost of supplies and materials ¹	1907 1902	\$3,649,243 \$1,884,539	\$479,940 \$281,178	\$509,973 \$150,187	\$2,062,699 \$1,136,979	\$510,027 \$186,321	\$86,604 \$129,874
Miscellaneous expenses.....	1907 1902	\$558,630 \$327,980	\$105,895 \$79,340	\$50,764 \$16,559	\$309,320 \$179,925	\$78,296 \$25,053	\$14,355 \$27,103
Salaries and wages.....	1907 1902	\$2,365,369 \$1,354,833	\$344,439 \$235,068	\$330,094 \$100,345	\$1,302,804 \$803,184	\$321,599 \$130,901	\$66,373 \$85,335
Primary-power plant: Total horsepower capacity ²	1907 1902	241,028 124,362	37,914 22,317	32,037 8,825	134,554 78,124	31,270 11,653	5,253 3,443
Generating plant: Kilowatt capacity of dynamos.....	1907 1902	159,265 85,122	25,087 15,155	20,157 5,747	89,558 52,520	21,069 8,264	3,394 3,430
Output of stations, kilowatt hours.....	1907 1902	196,435,621 148,913,431	27,540,654 21,820,941	25,600,947 11,717,107	110,478,858 95,812,332	28,335,699 14,611,775	4,479,463 4,951,576
Lamps wired for service: Arc.....	1907 1902	40,965 28,631	6,001 5,126	5,588 2,334	24,370 17,570	4,568 2,201	438 1,400
Incandescent ³	1907 1902	3,363,195 1,465,582	580,424 259,577	369,264 78,779	1,987,470 947,946	336,496 104,446	89,541 74,834
Other varieties—Nernst, vacuum, vapor, etc. ⁴	1907	3,753	770	42	2,570	167	204

¹ Includes cost of fuel amounting to \$2,517,986 in 1907 and \$1,124,403 in 1902.

² Includes capacity of auxiliary engines amounting to 1,134 horsepower in 1907 and 525 horsepower in 1902.

³ The number of incandescent lamps was largely an estimate and, although mostly reported on a 16-candlepower basis, embraces a considerable number ranging from 2 to 50 candlepower.

⁴ Not reported separately in 1902.

Large increases are shown for all but the Western division. In this division decreases are found for nearly every item, but these decreases are only apparent and not real. A number of municipal stations which were included in this class in 1902 could not properly be included in 1907 because in the latter year they did not supply the sole electric service to the places in which they were located. This was particularly the case in the states of California and Washington. If all the stations in these 2 states which were included in 1902 had also been included in 1907, uniform gains would have been shown for the Western division also.

It is noteworthy that proportionately larger gains

were reported for commercial lighting than for public lighting, and for incandescent lamps than for arc lamps. This was true for all geographic divisions. Compared with the increases for most of the items the output of stations in kilowatt hours shows small percentages of gain. This is in large part due to the difference in the stations included at the respective censuses, previously referred to, and to the fact that a somewhat larger amount was expended in 1907 than in 1902 for power purchased, the difference amounting to upward of \$70,000.

The statistics for municipal stations located in places where they furnished only a part of the electric service are shown, by geographic divisions, in Table 19.

TABLE 19.—MUNICIPAL CENTRAL ELECTRIC STATIONS WHICH DO NOT SUPPLY THE ENTIRE ELECTRIC SERVICE IN THE CITIES WHERE LOCATED, BY GEOGRAPHIC DIVISIONS: 1907 AND 1902.

	Census.	Total.	DIVISION.				
			North Atlantic.	South Atlantic.	North Central.	South Central.	Western.
Number of stations.....	1907 1902	138 83	27 10	15 10	69 52	14 9	13 2
Cost of construction and equipment.....	1907 1902	\$15,569,321 \$6,051,091	\$2,579,831 \$820,156	\$473,070 \$518,936	\$8,837,473 \$4,908,609	\$773,626 \$378,993	\$2,905,321 \$24,397
Gross income.....	1907 1902	\$4,249,888 \$2,041,909	\$855,382 \$318,628	\$224,786 \$210,179	\$2,129,017 \$1,411,673	\$271,171 \$92,549	\$769,532 \$8,880
Electric service.....	1907 1902	\$4,195,211 \$2,022,288	\$849,958 \$318,628	\$219,440 \$210,179	\$2,095,008 \$1,392,052	\$270,832 \$92,549	\$759,973 \$8,880
Lighting.....	1907 1902	\$4,014,091 \$2,007,128	\$777,665 \$309,618	\$214,132 \$204,733	\$2,071,438 \$1,391,348	\$255,757 \$92,549	\$695,099 \$8,880
Commercial.....	1907 1902	\$1,190,591 \$182,674	\$230,530 \$12,250	\$78,815 \$88,901	\$323,702 \$76,130	\$38,758 \$5,393	\$518,786
Public.....	1907 1902	\$2,823,500 \$1,824,454	\$547,135 \$297,368	\$135,317 \$115,832	\$1,747,736 \$1,315,218	\$216,999 \$87,156	\$176,313 \$8,880
Stationary motors.....	1907 1902	\$173,508 \$6,660	\$70,152 \$510	\$5,284 \$5,446	\$20,022 \$704	\$15,075	\$62,975
All other.....	1907 1902	\$7,612 \$8,500	\$2,141 \$8,500	\$24	\$3,548	.....	\$1,899
All other sources.....	1907 1902	\$54,677 \$19,621	\$5,424	\$5,346	\$34,009 \$19,621	\$339	\$9,559
Total expenses.....	1907 1902	\$2,593,946 \$1,173,830	\$476,541 \$172,767	\$160,771 \$118,321	\$1,397,501 \$818,717	\$160,147 \$60,971	\$398,986 \$3,054
Cost of supplies and materials ¹	1907 1902	\$1,318,444 \$537,752	\$225,857 \$72,814	\$95,899 \$59,811	\$725,162 \$374,097	\$78,919 \$29,969	\$192,607 \$1,061
Miscellaneous expenses.....	1907 1902	\$155,856 \$111,189	\$42,217 \$23,356	\$7,265 \$9,366	\$70,935 \$73,902	\$16,526 \$4,412	\$18,913 \$153
Salaries and wages.....	1907 1902	\$1,119,646 \$524,889	\$208,467 \$76,597	\$57,607 \$49,144	\$601,404 \$370,718	\$64,702 \$26,590	\$187,466 \$1,840
Primary-power plant: Total horsepower capacity ²	1907 1902	80,323 35,666	18,666 4,340	4,505 3,585	41,667 24,771	5,170 2,895	10,315 75
Generating plant: Kilowatt capacity of dynamos.....	1907 1902	49,751 28,255	10,238 2,730	2,602 2,722	26,432 20,643	4,064 2,129	6,415 34
Output of stations, kilowatt hours.....	1907 1902	93,027,167 46,991,008	21,320,984 6,649,005	4,699,450 5,355,864	48,526,331 32,053,189	6,030,279 2,872,360	12,450,123 60,590
Lamps wired for service:							
Arc.....	1907 1902	41,975 22,164	6,319 2,720	1,941 1,896	27,957 16,025	2,620 1,439	3,138 84
Incandescent ³	1907 1902	689,253 111,869	123,210 12,635	33,689 28,985	216,665 66,174	17,150 4,075	298,539
Other varieties—Nernst, vacuum, vapor, etc. ⁴	1907	5,117	379	21	1,039	20	3,658

¹ Includes cost of fuel amounting to \$714,797 in 1907 and \$321,421 in 1902.

² Includes capacity of auxiliary engines amounting to 370 horsepower in 1907 and 310 horsepower in 1902.

³ The number of incandescent lamps was largely an estimate and, although mostly reported on a 10-candlepower basis, embraces a considerable number ranging from 2 to 50 candlepower.

⁴ Not reported separately in 1902.

The number of stations shown in Table 19 is only about 10 per cent of the total for municipal stations for both 1907 and 1902, but the proportions of the totals for several other leading items were much greater. For 1907 these were as follows: Gross income, 30.3 per cent; sale of current, 30.8 per cent; expenses, 28.3 per cent; primary horsepower, 25 per cent; kilowatt capacity of dynamos, 23.8 per cent; output of stations, kilowatt hours, 32.1 per cent; number of arc lamps, 50.6 per cent; and number of incandescent lamps, 17 per cent. The corresponding proportions for 1902 were: Gross income, 29.3 per cent; sale of current, 29.6 per cent; expenses, 24.8 per cent; primary horsepower, 22.3 per cent; kilowatt capacity of dynamos, 24.9 per cent; output of stations, kilowatt hours, 24 per cent; number of arc lamps, 43.6 per cent; and number of incandescent lamps, 7.1 per cent. A comparison of

Tables 18 and 19 shows that public lighting occupied a far larger proportionate place in the business of the municipal stations included in the latter table than in that of those included in Table 18. In Table 19 the income from public lighting in 1907 constituted 66.4 per cent of the total income and in Table 18 only 28.9 per cent. This difference between the two classes of municipal stations is also reflected in their varying proportions of arc lamps, which find their chief use in public lighting of streets and parks. In Table 19 the arc lamps constituted 5.7 per cent of all lamps and in Table 18 only 1.2 per cent. As the primary object of municipal stations in places where they do not supply the sole electric service is probably in most cases the lighting of streets and parks, incandescent lighting for municipal stations would chiefly be confined to places where there were no commercial stations.

CENTRAL ELECTRIC LIGHT AND POWER STATIONS.

In the following tabular statement the relative importance of the two classes of municipal stations in the various geographic divisions is shown on the basis of income reported:

Municipal central electric stations that render the entire electric service and those that do not—Per cent distribution of income, by geographic divisions: 1907.

DIVISION.	Municipal stations which render the entire service.	Municipal stations which render only part of the service.
Total.....	100.0	100.0
North Atlantic.....	14.9	20.1
South Atlantic.....	14.3	5.3
North Central.....	54.0	50.1
South Central.....	14.0	6.4
Western.....	2.8	18.1

As indicated by the income, the North Central division reported slightly more than half of the municipal central-station industry for both classes of stations. The municipal stations which render the entire electrical service were, however, proportionately stronger here. In the other geographic divisions wide differences appear in the relative importance of the two classes of municipal stations. In the South Atlantic and the South Central, as in the North Central, the municipal stations which render the entire service were proportionately stronger—considerably more than twice as strong. In the North Atlantic and the Western divisions, on the other hand, the municipal stations which render only part of the service were proportionately stronger, and in the case of the Western division more than six times as strong.

CHAPTER III. POWER EQUIPMENT.

Primary-power equipment of central stations and electric railways.—The equipment of the primary-power plants as reported to the Bureau of the Census consists of the number and horsepower of the steam engines, steam turbines, gas engines, water wheels, and auxiliary engines. With the exception of the auxiliary engines, which represent the power used within the station to operate pumps, etc., these machines are necessarily closely allied to the equipment of the gen-

erating plant. In a few instances the primary-power plant and the electric generators are conducted under independent ownership, but the two classes of equipment are so generally interdependent that the statistics for them are associated in various tables throughout the report. The totals for the primary machines in central stations and electric-railway plants are given in Table 20.

TABLE 20.—CENTRAL ELECTRIC STATIONS AND ELECTRIC RAILWAYS—NUMBER AND HORSEPOWER OF THE PRIMARY-POWER MACHINES, BY KIND OF POWER: 1907 AND 1902.

KIND OF POWER.	TOTAL.		CENTRAL STATIONS.		ELECTRIC RAILWAYS.		PER CENT OF INCREASE.		
	1907	1902	1907	1902	1907	1902	Total.	Central stations.	Electric railways.
Total:									
Number.....	14,635	10,661	10,998	7,850	3,637	2,811	37.3		
Horsepower.....	6,618,011	3,204,333	4,098,188	1,845,048	2,519,823	1,359,285	106.5	40.1	29.4
Steam engines:									
Number.....	9,088	8,266	6,829	5,930	2,259	2,336	9.9	15.2	13.3
Horsepower.....	3,642,819	2,678,074	1,810,040	1,379,941	1,832,779	1,298,133	36.0	31.2	41.2
Steam turbines:									
Number.....	629	(²)	377	(²)	252	(²)			
Horsepower.....	1,352,814	(²)	817,410	(²)	535,404	(²)			
Gas engines:									
Number.....	504	180	463	165	41	15	180.0	180.6	173.3
Horsepower.....	72,163	14,106	55,828	12,181	16,335	1,925	411.6	358.3	748.3
Water wheels:									
Number.....	2,709	1,549	2,481	1,390	228	159	74.9	78.5	43.4
Horsepower.....	1,441,048	487,625	1,349,087	438,472	91,961	49,153	195.5	207.7	87.1
Auxiliary engines:									
Number.....	1,705	666	848	365	857	301	156.0	132.3	185.4
Horsepower.....	109,167	24,828	65,823	14,454	43,344	10,074	345.1	355.4	330.3

¹ Decrease.

² In 1902 steam turbines were included with steam engines.

The combined horsepower of the engines and water wheels used to operate the electric machines in the central stations and railway plants more than doubled during the five years ending with 1907. The power plants of the central stations show the greater gain, representing 57.6 per cent of the total horsepower in 1902 and 61.9 per cent in 1907.

While steam is the most important primary power in both branches of the industry, its lead is greatest in the railway plants, where at both censuses it formed about 95 per cent of all the primary power reported. It was in this kind of primary power that the electric railways showed their largest proportion of the total, namely, 47.4 and 48.5 per cent, respectively, in 1907 and 1902. In respect to steam engines alone the electric railways showed a marked relative gain over 1902, but having 81,808 less horsepower than the central stations in that year as compared with an excess of 22,739 horsepower in 1907. The true measure of the comparative importance of steam power in the two branches of the electrical industry, however, is furnished by a comparison of the totals for both steam

engines and steam turbines, and this shows that, as compared with electric railways, the central stations reported an excess of 259,267 steam horsepower in 1907 and 81,808 in 1902.

The horsepower of gas engines, although forming but a small proportion of the total primary power, showed a decided increase in both branches of the electrical industry, but the proportion was greatest for the electric railways, this particular kind of power having increased from 13.6 per cent in 1902 to 22.6 per cent in 1907. Water power has developed more rapidly as connected with the central stations than with the electric railways, the proportion of the total reported by the former having increased from 89.9 per cent in 1902 to 93.6 per cent in 1907.

CENTRAL STATIONS.

Engines and water wheels.—Table 21 gives statistics of the primary-power equipment of commercial and municipal central stations for 1907 and 1902 and shows the percentages of increase.

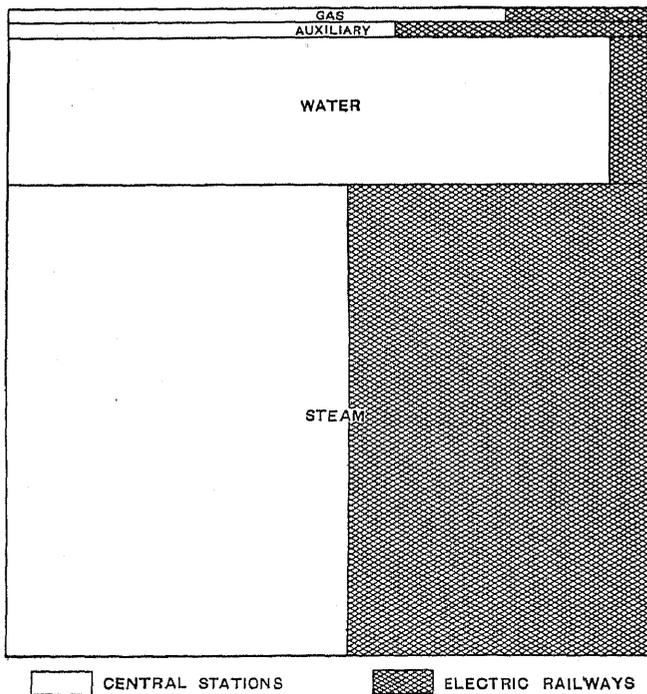
CENTRAL ELECTRIC LIGHT AND POWER STATIONS.

TABLE 21.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—NUMBER AND HORSEPOWER OF THE PRIMARY-POWER MACHINES, BY KIND OF POWER: 1907 AND 1902.

KIND OF POWER.	TOTAL.		COMMERCIAL.		MUNICIPAL.		PER CENT OF INCREASE.		
	1907	1902	1907	1902	1907	1902	Total.	Commer- cial.	Municipal.
Total:									
Number.....	10,998	7,850	8,981	6,654	2,017	1,196	40.1	35.0	68.6
Horsepower.....	4,098,188	1,845,048	3,776,837	1,685,020	321,351	160,028	122.1	124.1	100.8
Steam engines:									
Number.....	6,820	5,930	5,144	4,870	1,685	1,060	15.2	5.6	59.0
Horsepower.....	1,810,640	1,379,941	1,546,007	1,232,923	264,033	147,018	31.2	25.4	79.6
Steam turbines:									
Number.....	377	(1)	348	(1)	29	(1)			
Horsepower.....	817,410	(1)	798,025	(1)	19,385	(1)			
Gas engines:									
Number.....	463	165	385	147	78	18	180.6	161.9	333.3
Horsepower.....	55,828	12,181	49,746	11,224	6,082	957	358.3	343.2	535.5
Water wheels:									
Number.....	2,481	1,390	2,328	1,308	153	82	78.5	78.0	86.6
Horsepower.....	1,349,087	438,472	1,318,740	427,254	30,347	11,218	207.7	208.7	170.5
Auxiliary engines:									
Number.....	848	365	776	329	72	36	132.3	135.9	100.0
Horsepower.....	65,823	14,454	64,319	13,619	1,504	835	355.4	372.3	83.7

1 In 1902 steam turbines were included with steam engines.

DIAGRAM 1.—Central stations and electric railways, by character of primary power: 1907.

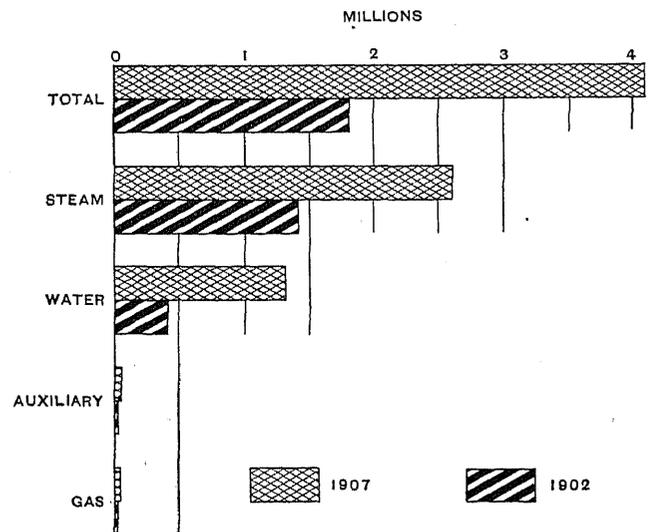


In 1907 the primary machines of the central stations averaged 869 horsepower per station as compared with 510 horsepower in 1902, an increase of 359 horsepower, or 70.4 per cent. The commercial stations averaged 1,091 horsepower in 1907 and 601 horsepower in 1902, showing an increase of 490 horsepower, or 81.5 per cent; while the municipal stations averaged 257 horsepower in 1907 and 196 horsepower in 1902, showing an increase of 61 horsepower, or 31.1 per cent.

Steam has contributed more than any other kind of power to the great increase, 1,247,509 horsepower, in the primary power of central stations, and the steam turbine, which was first reported separately in this industry at the census of 1907, has become a very im-

portant factor in the electrical generating equipment. Water is used as the primary power in a constantly increasing number of stations, and the power of the wheels increased by 910,615 horsepower during the five years ending with 1907. Although the greatest absolute increase was shown for steam power, in percentage of increase, it was surpassed by both gas and water power. The percentages are: Steam power, 90.4 per cent; water power, 207.7 per cent; and gas power, 358.3 per cent.

DIAGRAM 2.—Central stations, by character of primary power: 1907 and 1902.



Of the two classes of stations the commercial shows by far the greater amount of power and the larger increase since 1902. In 1907 their equipment represented 92.2 per cent of the total primary power, the proportion having increased from 91.3 per cent in 1902. Thus, while the municipal electric stations, as compared with many industries, have a large motive-power equipment, it forms but a small proportion (7.8 per cent) of the primary power used for the generation of electricity in central stations.

DIAGRAM 3.—CENTRAL ELECTRIC STATIONS—PRIMARY POWER, BY STATES, ARRANGED IN ORDER OF THEIR RELATIVE IMPORTANCE: 1907 AND 1902.

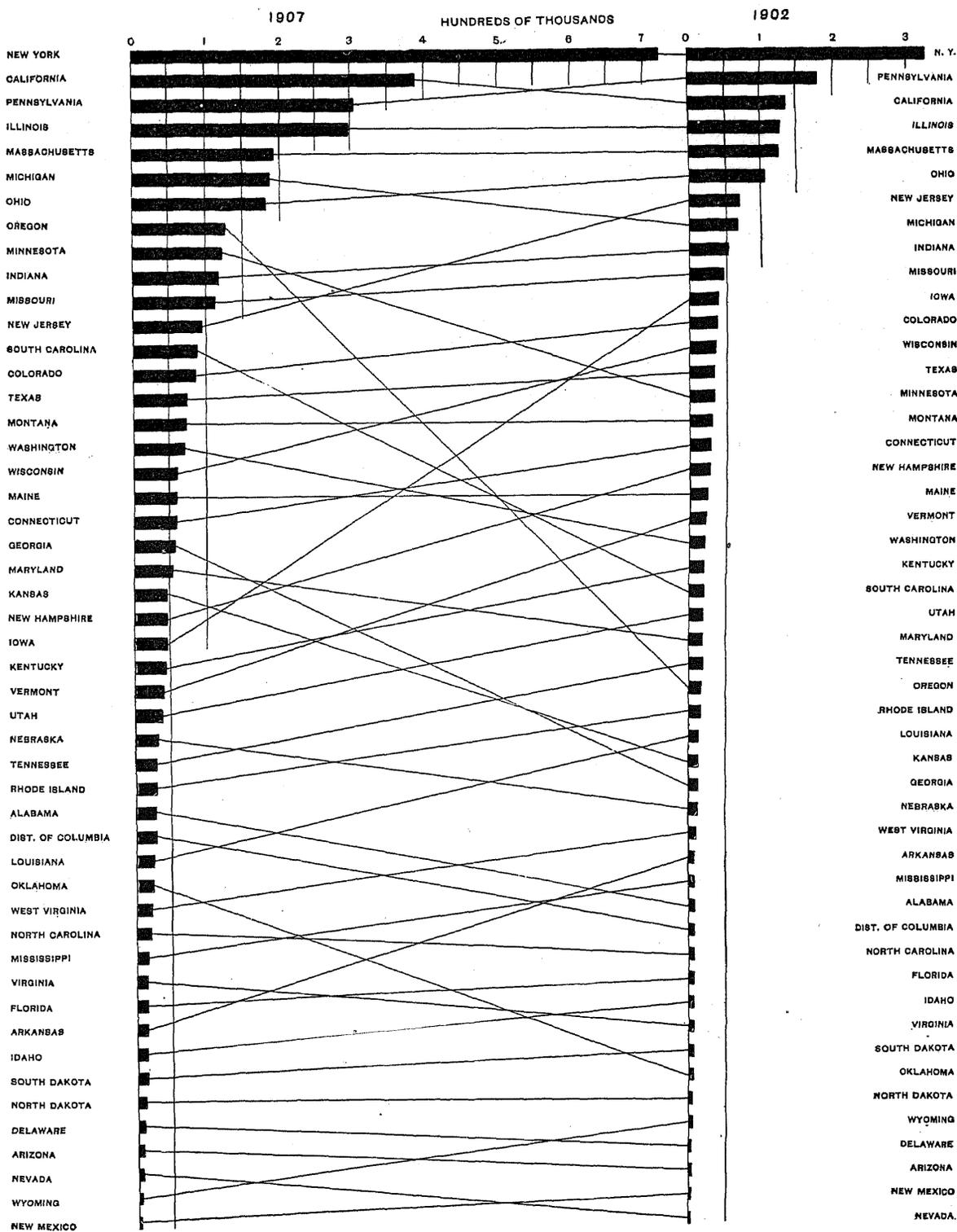


Table 22 shows the per cent distribution, by kind of power, of the primary-power equipment of commercial and municipal stations for 1907 and 1902.

TABLE 22.—Commercial and municipal central electric stations—Per cent distribution, by kind of primary-power machines: 1907 and 1902.

KIND OF POWER.	TOTAL.		COMMERCIAL.		MUNICIPAL.	
	1907	1902	1907	1902	1907	1902
Total:						
Number.....	100.0	100.0	100.0	100.0	100.0	100.0
Horsepower.....	100.0	100.0	100.0	100.0	100.0	100.0
Steam engines:						
Number.....	62.1	75.5	57.3	73.2	53.5	88.6
Horsepower.....	44.2	74.8	40.9	73.2	52.2	91.9
Steam turbines:						
Number.....	3.4	(1)	3.9	(1)	1.4	(1)
Horsepower.....	19.9	(1)	21.1	(1)	0.0	(1)
Gas engines:						
Number.....	4.2	2.1	4.3	2.2	3.9	1.5
Horsepower.....	1.4	0.7	1.3	0.7	1.9	0.6
Water wheels:						
Number.....	22.6	17.7	25.9	19.7	7.6	6.9
Horsepower.....	32.9	23.8	34.9	25.4	9.4	7.0
Auxiliary engines:						
Number.....	7.7	4.6	8.6	4.9	3.6	3.0
Horsepower.....	1.6	0.8	1.7	0.8	0.5	0.5

¹ In 1902 steam turbines were included with steam engines.

Steam engines furnished the largest proportion of

horsepower for both the commercial and the municipal stations, but for each of the two classes of stations their relative importance has decreased considerably since 1902, while that of the water wheels and gas engines has increased. If a division of the primary power, including auxiliary power, be made into the three classes—steam, gas, and water—it is found that of the total power in central stations in 1907, 65.7 per cent was steam; 1.4 per cent, gas; and 32.9 per cent, water. The corresponding proportions for 1902 were: Steam, 75.6 per cent; gas, seven-tenths of 1 per cent; and water, 23.8 per cent. Of the proportion for steam in 1907, the commercial stations reported 58.8 per cent of the total primary power and the municipal stations 6.9 per cent. The corresponding proportions in 1902 were 67.6 per cent and 8 per cent, respectively.

Steam engines and steam turbines.—Inasmuch as steam turbines were not reported separately in 1902, they are, for comparative purposes, combined with steam engines for 1907 in Tables 23 and 24, which give detailed statistics of the steam-power equipment of commercial and municipal central stations for 1907 and 1902.

TABLE 23.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—STEAM ENGINES AND STEAM TURBINES, BY HORSEPOWER CAPACITY: 1907 AND 1902.

CLASS OF ENGINES.	TOTAL.		COMMERCIAL.		MUNICIPAL.		PER CENT OF INCREASE.		
	1907	1902	1907	1902	1907	1902	Total.	Com-mercial.	Municipal.
Total:									
Number.....	7,206	5,930	5,492	4,870	1,714	1,060	21.5	12.8	61.7
Horsepower.....	2,627,460	1,379,941	2,344,032	1,232,923	283,418	147,018	90.4	90.1	92.8
500 horsepower and under:									
Number.....	6,248	5,451	4,584	4,407	1,664	1,044	14.6	4.0	59.4
Horsepower.....	1,035,583	849,336	794,205	715,418	241,378	133,918	21.9	11.0	80.2
Over 500 but under 1,000 horsepower:									
Number.....	498	278	400	266	38	12	79.1	72.9	216.7
Horsepower.....	345,158	193,570	318,818	184,670	26,340	8,900	78.3	72.6	196.0
1,000 but under 2,000 horsepower:									
Number.....	249	149	230	145	10	4	67.1	64.8	150.0
Horsepower.....	316,588	187,485	306,188	183,285	10,400	4,200	68.9	67.1	147.6
2,000 but under 5,000 horsepower:									
Number.....	148	52	146	52	2		184.6	180.8	
Horsepower.....	407,695	149,550	402,395	149,550	5,300		172.6	169.1	
5,000 horsepower and over:									
Number.....	63	(1)	63	(1)					
Horsepower.....	522,426	(1)	522,426	(1)					

¹ Included in "2,000 but under 5,000 horsepower." The class "5,000 horsepower and over" not called for at the census of 1902.

The figures in Tables 23 and 24 show that the greatest increases have taken place in the horsepower of the largest types of steam engines. Of the total steam power reported for 1907, 35.4 per cent was represented by machines with a capacity of 2,000 horsepower or over, while machines of this type represented only 10.8 per cent of the steam power reported for 1902. In 1902, of the total steam power, 61.5 per cent was in the class of "500 horsepower and under," and in 1907 the proportion had decreased to 39.4 per

cent. The commercial stations naturally made the most marked gains in the large units of power, increasing from 12.1 per cent for the class of 2,000 and over in 1902 to 39.5 per cent in 1907, and decreasing from 58 per cent for the class of 500 or under in 1902 to 33.9 per cent in 1907. The municipal stations, although showing no marked changes in the relative proportions of the several classes, manifest a tendency toward the larger units of steam power.

TABLE 24.—Commercial and municipal central electric stations—Per cent distribution, by number and horsepower capacity of steam engines and steam turbines: 1907 and 1902.

CLASS OF ENGINES.	TOTAL.		COMMERCIAL.		MUNICIPAL.	
	1907	1902	1907	1902	1907	1902
Total:						
Number.....	100.0	100.0	100.0	100.0	100.0	100.0
Horsepower.....	100.0	100.0	100.0	100.0	100.0	100.0
500 horsepower and under:						
Number.....	86.7	91.9	83.5	90.5	97.1	98.5
Horsepower.....	39.4	61.5	33.9	58.0	35.2	91.1
Over 500 but under 1,000 horsepower:						
Number.....	6.9	4.7	8.4	5.5	2.2	1.1
Horsepower.....	13.1	14.0	13.6	15.0	9.3	6.1
1,000 but under 2,000 horsepower:						
Number.....	3.5	2.5	4.4	3.0	0.6	0.4
Horsepower.....	12.0	13.6	13.1	14.9	3.7	2.9
2,000 but under 5,000 horsepower:						
Number.....	2.1	0.9	2.7	1.1	0.1	.....
Horsepower.....	15.5	10.8	17.2	12.1	1.9	.....
5,000 horsepower and over:						
Number.....	0.9	(1)	1.1	(1)	.....	.....
Horsepower.....	19.9	(1)	22.3	(1)	.....	.....

¹ Included in "2,000 but under 5,000 horsepower." The class "5,000 horsepower and over" not called for at the census of 1902.

There were only 3 states—Nevada, South Carolina, and Utah—for which a smaller amount of primary steam power was reported in 1907 than in 1902.

While only 9,964 steam horsepower was reported for these states in 1907 and 12,990 in 1902, it is interesting to note that for each state there was an increase in water power far greater than the decrease in steam power. In each of the following states the steam power reported for 1907 exceeded 100,000 horsepower: New York, 410,007 horsepower; Illinois, 286,958; Pennsylvania, 258,163; Ohio, 170,251; Massachusetts, 169,617; California, 133,299; and Missouri, 102,044. The total for these states amounted to 1,530,339 horsepower, or 58.2 per cent of the total steam power for all states.

The increase in the number and importance of the steam turbines makes it desirable to segregate the statistics for the two kinds of engines operated by steam, and Tables 25 and 26 show the totals and percentages for engines exclusive of steam turbines. The statistics for 1902, however, include the figures for a comparatively small number of steam turbines, because they were not deemed of sufficient importance to be reported separately for that year, and to this extent the comparison of the figures for the two census years is vitiated.

TABLE 25.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—NUMBER AND HORSEPOWER OF STEAM ENGINES, EXCLUSIVE OF STEAM TURBINES: 1907 AND 1902.

CLASS OF ENGINES.	TOTAL.		COMMERCIAL.		MUNICIPAL.		PER CENT OF INCREASE.		
	1907	1902	1907	1902	1907	1902	Total.	Commer- cial.	Municipal.
Total:									
Number.....	6,829	5,930	5,144	4,870	1,685	1,060	15.2	5.6	59.0
Horsepower.....	1,810,040	1,379,941	1,546,007	1,232,923	264,033	147,018	31.2	25.4	79.6
500 horsepower and under:									
Number.....	6,183	5,451	4,535	4,407	1,648	1,044	13.4	2.9	57.9
Horsepower.....	1,018,566	849,336	781,673	715,418	236,893	133,918	19.9	9.3	76.9
Over 500 but under 1,000 horsepower:									
Number.....	375	278	342	266	33	12	34.9	28.6	175.0
Horsepower.....	259,478	193,570	236,638	184,670	22,840	8,900	34.0	28.1	156.6
1,000 but under 2,000 horsepower:									
Number.....	182	149	178	145	4	4	22.1	22.8	.....
Horsepower.....	230,216	187,485	225,916	183,285	4,300	4,200	22.8	23.3	2.4
2,000 but under 5,000 horsepower:									
Number.....	70	52	70	52	.....	.....	.....	.....	.....
Horsepower.....	186,280	149,550	186,280	149,550	.....	.....	.....	.....	.....
5,000 horsepower and over:									
Number.....	19	(1)	19	(1)	.....	.....	.....	.....	.....
Horsepower.....	115,500	(1)	115,500	(1)	.....	.....	.....	.....	.....

¹ Included in "2,000 but under 5,000 horsepower." The class "5,000 horsepower and over" not called for at the census of 1902.

While a considerable increase took place in the horsepower of the smaller engines in both classes of stations, it has not been sufficient to overcome the increase in the larger units. Therefore the relative importance of the engines of "500 horsepower and under" decreased from 61.5 per cent of the total in 1902 to 56.3 per cent in 1907, the greatest relative decrease, from 58 per cent to 50.6 per cent, occurring in the commercial stations, which contain all of the large engines.

As would naturally be expected, the municipal stations show no large steam engines. There were no machines of more than 2,000 horsepower reported for

such stations at either census, and only 4 that had an indicated horsepower of 1,000 and over. As a rule the municipal stations are small, and therefore contain a large proportion of the small machines.

Little change was shown in the proportion of engines of "Over 500 but under 1,000 horsepower," 14.3 per cent in 1907 and 14 per cent in 1902, but there was a decline in the proportion of engines of "1,000 but under 2,000 horsepower," from 13.6 per cent in 1902 to 12.7 per cent in 1907. As already indicated, a decided increase was manifest in the proportion of engines of over 2,000 horsepower, from 10.8 per cent in 1902 to 16.7 per cent in 1907.

DIAGRAM 4.—CENTRAL ELECTRIC STATIONS—STEAM AND WATER POWER, BY STATES, ARRANGED IN ORDER OF THEIR RELATIVE IMPORTANCE: 1907.

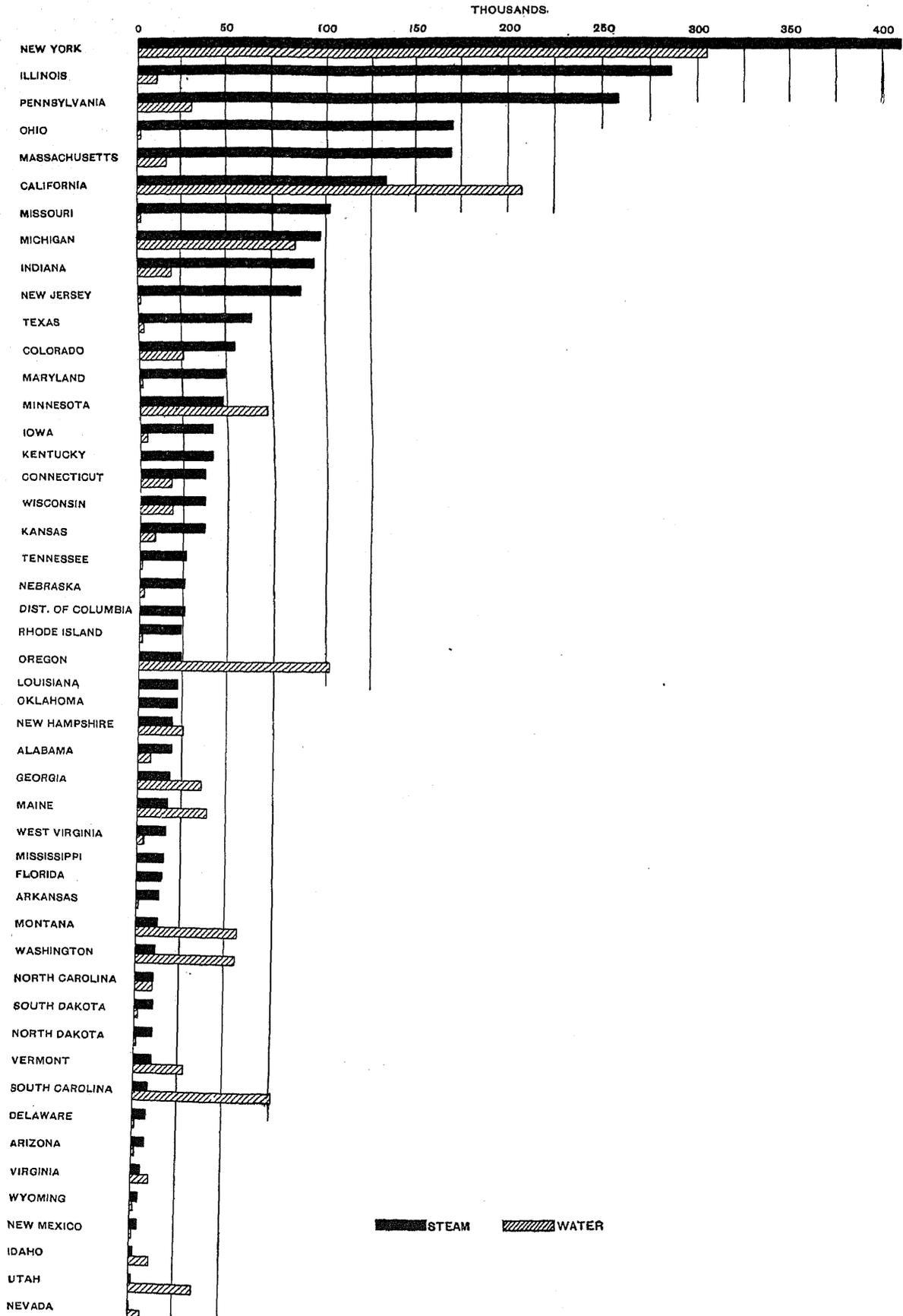


TABLE 26.—Commercial and municipal central electric stations—
Per cent distribution, by number and horsepower capacity of steam engines, exclusive of steam turbines: 1907 and 1902.

CLASS OF ENGINES.	TOTAL.		COMMERCIAL.		MUNICIPAL.	
	1907	1902	1907	1902	1907	1902
Total:						
Number.....	100.0	100.0	100.0	100.0	100.0	100.0
Horsepower.....	100.0	100.0	100.0	100.0	100.0	100.0
500 horsepower and under:						
Number.....	90.5	91.9	88.2	90.5	97.8	98.5
Horsepower.....	56.3	61.5	50.6	58.0	89.7	91.1
Over 500 but under 1,000 horsepower:						
Number.....	5.5	4.7	6.6	5.5	2.0	1.1
Horsepower.....	14.3	14.0	15.3	15.0	8.7	6.1
1,000 but under 2,000 horsepower:						
Number.....	2.7	2.5	3.5	3.0	0.2	0.4
Horsepower.....	12.7	13.6	14.6	14.9	1.6	2.9
2,000 but under 5,000 horsepower:						
Number.....	1.0	0.9	1.4	1.1		
Horsepower.....	10.3	10.8	12.0	12.1		
5,000 horsepower and over:						
Number.....	0.3	(¹)	0.4	(¹)		
Horsepower.....	6.4	(¹)	7.5	(¹)		

¹ Included in "2,000 but under 5,000 horsepower." The class "5,000 horsepower and over" not called for at the census of 1902.

Since all engines with an indicated horsepower of 2,000 or over were reported as a single group at the census of 1902, it is impracticable to determine the number and horsepower of the machines of 5,000 and over in operation in that year to compare with those reported in 1907. At the latter census these engines were distributed as follows: New York, 11 engines with 60,500 horsepower; California, 5 with 34,500; Pennsylvania, 1 with 8,000; Maryland, 1 with 7,500; and Illinois, 1 with 5,000.

Steam turbines.—These engines appear to be admirably adapted to central-station work, and although a number of engines of this type of small horsepower capacity were reported, it is evident from the statistics in Table 27 that the majority were of large horsepower and especially fitted to meet the requirements of large centers of distribution.

The municipal stations contained comparatively few steam turbines, the majority of which (55.2 per cent) were of the smaller type. The turbines of less than 2,000 horsepower, as shown in Table 27, formed 72.7 per cent of the total power of all these engines in the municipal stations and but 22 per cent of the power of those in the commercial stations. In commercial stations the large engines, those having over 2,000 horsepower, represented 78.1 per cent of the total turbine power. Practically one-half of the horsepower of the steam turbines was in units of 5,000 and over. The extent to which the steam turbine predominates among the machines of this largest capacity is indicated by the fact that in 1907 there were 44 turbines in this class, with a total of 406,926 horsepower, as compared with 19 steam engines of other types of 115,500 horsepower and 55 water wheels of

339,800 horsepower. Of the total for all kinds of primary power, excluding auxiliary engines, the steam turbine furnished 20.3 per cent as compared with 44.9 per cent for other classes of steam engines and 33.5 per cent for water wheels.

TABLE 27.—Commercial and municipal central electric stations—
Number and horsepower of steam turbines, by horsepower capacity, with per cent distribution: 1907.¹

CLASS OF STEAM TURBINES.	Total.	Com-mercial.	Municipal.	PER CENT DISTRIBUTION.		
				Total.	Com-mercial.	Municipal.
Total:						
Number.....	377	348	29	100.0	100.0	100.0
Horsepower.....	817,410	798,025	19,385	100.0	100.0	100.0
500 horsepower and under:						
Number.....	65	49	16	17.2	14.1	55.2
Horsepower.....	17,017	12,532	4,485	2.1	1.6	23.1
Over 500 but under 1,000 horsepower:						
Number.....	123	118	5	32.6	33.9	17.2
Horsepower.....	85,680	82,180	3,500	10.5	10.3	18.1
1,000 but under 2,000 horsepower:						
Number.....	67	61	6	17.8	17.5	20.7
Horsepower.....	86,372	80,272	6,100	10.6	10.1	31.5
2,000 but under 5,000 horsepower:						
Number.....	78	76	2	20.7	21.8	6.9
Horsepower.....	221,415	216,115	5,300	27.1	27.1	27.3
5,000 horsepower and over:						
Number.....	44	44		11.7	12.6	
Horsepower.....	406,926	406,926		49.8	51.0	

¹ Comparison with 1902 impracticable, since in that year steam turbines were included with steam engines.

Steam turbines were reported as in use in some of the central stations of all the states and territories, except Virginia, North Carolina, South Carolina, North Dakota, Idaho, Utah, Nevada, and New Mexico. In all these states together only 41,130 steam horsepower was reported for the stations, and it is evident that water power, of which 147,979 horsepower was reported, was more economical, or that the business did not justify or require the installation of turbines.

Nearly one-half (48.2 per cent) of the horsepower of the steam turbines was contained in 3 states—New York, Illinois, and Massachusetts. New York alone reported 24.9 per cent of this class of power, while as between steam engines and steam turbines in that state the latter represented 49.7 per cent of their total horsepower. Of the total steam power in Illinois, 48.3 per cent was reported for steam turbines, while of the total in Massachusetts, the proportion contributed by steam turbines was considerably less, 30.3 per cent. Although steam turbines were in use in 187 stations, in only 18 were they the sole primary power.

That the steam turbine is specially adapted to large centers of distribution will be seen from Table 28.

More than three-fifths of the horsepower reported for steam turbines was found in the 14 cities named, and their 90 engines showed the enormous average of 5,559 horsepower, as compared with an average of 2,168 for the country as a whole.

TABLE 28.—Central electric stations in selected cities—Number and horsepower of steam turbines: 1907.

CITY.	Number.	Horsepower.	Per cent distribution.
Total for United States.....	377	817,410	100.0
Total for selected cities.....	90	500,335	61.2
New York.....	22	170,600	20.9
Chicago.....	10	116,500	14.3
St. Louis.....	10	38,882	4.8
Boston.....	3	30,000	3.7
Philadelphia.....	7	25,468	3.1
Los Angeles.....	6	25,360	3.1
Cleveland.....	6	22,000	2.7
Washington.....	4	21,000	2.6
Baltimore.....	6	10,200	1.2
Louisville.....	2	9,000	1.1
Denver.....	4	8,525	1.0
Indianapolis.....	5	7,800	1.0
Cincinnati.....	1	7,500	0.9
Hartford.....	4	7,500	0.9

Gas engines.—The 463 engines denominated as gas engines in Table 21, with a total of 55,828 horsepower, are composed of 294 gas engines, with 45,330 horsepower; 136 gasoline engines, with 4,313 horsepower; and 33 oil engines, with 6,185 horsepower. These machines were used in 294 stations, of which 180, with 292 engines and a total of 23,487 horsepower, were operated wholly by machines of this class. Of these 180 stations, 137, with 19,532 horsepower, were commercial stations, and 43, with 3,955 horsepower, municipal stations. Although the proportion of the total horsepower in central stations which is represented by the gas engines is comparatively small (1.4 per cent of the total primary power), the number and importance of the gas engines have nevertheless increased largely since 1902. As a rule these engines are of a small type and their use has been confined largely to small plants. Lately, however, a larger type of machine is coming into use, and one commercial station operated 3 gas engines, with a total of 16,200 horsepower, which furnished motive power to operate 3 dynamos of slightly less than 4,000 kilowatts each. The exact size of each engine was not reported on the census schedule, but it appears that the smallest engine in this class shown as connected with a generator is one of 6 horsepower, which operated a 3-kilowatt dynamo. California reported gas engines with a total of 16,585 horsepower, or 29.7 per cent of the total of this class of primary power; Pennsylvania reported 7,469 horsepower; Ohio, 5,628; New York, 3,315; Texas, 3,058; and Wisconsin, 2,079. The horsepower of the gas engines of these 6 states amounted to 38,134 and formed 68.3 per cent of the total horsepower reported for all gas engines in both commercial and municipal stations.

Internal-combustion oil engines.—At the census of 1907, 18 stations reported the use of oil engines of the internal-combustion type, similar in character to the gas engine, with 6,185 horsepower; and 10 stations,

with 18 of these engines, relied upon them entirely for primary power. The following tabular statement shows the states in which these stations are located:

Internal-combustion oil engines—Number and horsepower, by states: 1907.

STATE.	Number of stations.	ENGINES.	
		Number.	Horsepower.
Total.....	18	33	6,185
Connecticut.....	2	4	600
Illinois.....	1	2	240
Louisiana.....	1	1	170
Massachusetts.....	2	3	570
New Hampshire.....	2	3	550
New Jersey.....	1	1	270
New York.....	1	1	170
Ohio.....	2	4	900
Pennsylvania.....	1	2	190
Rhode Island.....	1	4	1,000
Texas.....	3	7	1,450
Wisconsin.....	1	1	75

Water power.—The ease with which electric current may be transmitted long distances and the economy connected with its generation by the use of water power have not only greatly increased the amount of this kind of power in 1907 as compared with 1902, but indicate its continued development. The statistics represent only the central stations that were in actual operation during the respective census years. The construction of hydro-electric plants is proceeding rapidly; a number were under construction during 1907 but had not commenced operations before the close of the year; and the Bureau of the Census was advised also that extensive water-power plants were contemplated in various sections of the country. The exhaustion of the fuel supply will further stimulate the erection of these plants, but naturally their increase will be slowest in the states where fuel is most abundant.

The horsepower of the water wheels in the central stations during 1907, was more than three times as great as it was in 1902. Although the actual increase was less than that for steam power, its proportion of the total primary power, excluding auxiliary engines, increased from 24 to 33.5 per cent, while the proportion for steam power shows a nearly corresponding decrease, from 75.4 per cent in 1902 to 65.2 per cent in 1907. The greatest increase occurred in the commercial stations, which contained 97.4 per cent of the water power in 1902 and 97.8 per cent in 1907.

As with steam power, the increase in water power is due primarily to the installation of large units of 2,000 horsepower and over. The increase in the capacity of these machines represented 61.9 per cent of the total increase in water power. In other words, the large water wheels furnished about three-fifths and the small wheels two-fifths of the increase.

TABLE 29.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—NUMBER AND HORSEPOWER OF WATER WHEELS, BY HORSEPOWER CAPACITY: 1907 AND 1902.

CLASS OF ENGINES.	TOTAL.		COMMERCIAL.		MUNICIPAL.		PER CENT OF INCREASE.		
	1907	1902	1907	1902	1907	1902	Total.	Commer- cial.	Municipal.
Total:									
Number.....	2,481	1,390	2,328	1,308	153	82	78.5	78.0	86.3
Horsepower.....	1,349,087	438,472	1,318,740	427,254	30,347	11,218	207.7	208.7	170.5
500 horsepower and under:									
Number.....	1,910	1,192	1,761	1,112	149	80	60.2	58.4	86.2
Horsepower.....	320,636	174,559	296,689	164,981	23,947	9,578	83.7	79.8	150.0
Over 500 but under 1,000 horsepower:									
Number.....	244	85	243	84	1	1	187.1	189.3	.....
Horsepower.....	161,051	57,160	160,251	56,520	800	640	181.8	183.5	25.0
1,000 but under 2,000 horsepower:									
Number.....	161	81	160	80	1	1	98.8	100.0	.....
Horsepower.....	196,620	99,453	195,420	98,453	1,200	1,000	97.7	98.5	20.0
2,000 but under 5,000 horsepower:									
Number.....	111	32	109	32	2	.....	246.9	240.6	.....
Horsepower.....	330,980	107,300	326,580	107,300	4,400	.....	208.5	204.4	.....
5,000 horsepower and over:									
Number.....	55	(1)	55	(1)	.....	.....	.....	.....	.....
Horsepower.....	339,800	(1)	339,800	(1)	.....	.....	.....	.....	.....

¹ Included in "2,000 but under 5,000 horsepower." The class "5,000 horsepower and over" not called for at the census of 1902.

The municipal stations contained only 3 of the water wheels with 1,000 horsepower and over in 1907 and but 1 in 1902. This small number of large wheels is, however, natural, as municipal plants are generally constructed for the purpose of supplying current to a single community and often for a specific purpose, and the equipment is limited to the probable needs of that community or purpose. Commercial plants, on the other hand, are constructed upon a broader, larger plan and are therefore more frequently designed to furnish current to any place to which it can be delivered at a profit.

TABLE 30.—Commercial and municipal central electric stations—Per cent distribution, by number and horsepower capacity of water wheels: 1907 and 1902.

CLASS OF WATER WHEELS.	TOTAL.		COMMERCIAL.		MUNICIPAL.	
	1907	1902	1907	1902	1907	1902
Total:						
Number.....	100.0	100.0	100.0	100.0	100.0	100.0
Horsepower.....	100.0	100.0	100.0	100.0	100.0	100.0
500 horsepower and under:						
Number.....	77.0	85.8	75.6	85.0	97.4	97.6
Horsepower.....	23.8	39.8	22.5	38.6	78.9	85.4
Over 500 but under 1,000 horsepower:						
Number.....	9.8	6.1	10.4	6.4	0.7	1.2
Horsepower.....	11.9	13.0	12.2	13.2	2.6	5.7
1,000 but under 2,000 horsepower:						
Number.....	6.5	5.8	6.9	6.1	0.7	1.2
Horsepower.....	14.6	22.7	14.8	23.0	4.0	8.9
2,000 but under 5,000 horsepower:						
Number.....	4.5	2.3	4.7	2.4	1.3	.....
Horsepower.....	24.5	24.5	24.8	25.1	14.5	.....
5,000 horsepower and over:						
Number.....	2.2	(1)	2.4	(1)	.....	.....
Horsepower.....	25.2	(1)	25.8	(1)	.....	.....

¹ Included in "2,000 but under 5,000 horsepower." The class "5,000 horsepower and over" not called for at the census of 1902.

With the exception of Kentucky and North Dakota, in which states very little water power is utilized in electric plants, every state that reported water power in 1902 showed an increased use of such power in 1907. Alabama, Arizona, and Delaware had no central stations operated by water power in 1902, but each contained stations so equipped in 1907. Some of the

most marked gains in water power occurred in the following states: New York, from 128,785 horsepower in 1902 to 305,950 in 1907; California, from 78,933 to 208,444; Oregon, 11,195 to 102,052; Michigan, 16,085 to 85,738; Minnesota, 6,040 to 71,656; South Carolina, 10,415 to 75,430; Washington, 17,238 to 56,118; Montana, 24,000 to 56,987; and Georgia, 6,121 to 36,335. The water power reported by these 9 states represented 68.1 per cent of the total of this kind of primary power for all central stations in the United States in 1902 and 74 per cent in 1907. No water power was reported by the central stations in Florida, Louisiana, Mississippi, Oklahoma, or the District of Columbia.

For the purpose of comparing the average horsepower both of the stations as equipped with the various kinds of primary power and of the different classes of machines reported in 1907 and in 1902 the following table is given:

TABLE 31.—Commercial and municipal central electric stations—Average horsepower, per station and per machine, of primary power: 1907 and 1902.

KIND OF POWER.	TOTAL.		COMMERCIAL.		MUNICIPAL.	
	1907	1902	1907	1902	1907	1902
Total power:						
Per station.....	869	510	1,091	601	257	196
Per machine.....	373	235	421	253	159	134
Steam engines and steam tur-						
bines:						
Per station.....	675	445	844	523	254	198
Per machine.....	365	233	427	253	165	139
Steam engines:						
Per station.....	489	445	593	523	240	198
Per machine.....	265	233	301	253	157	139
Steam turbines:						
Per station.....	4,371	(1)	4,694	(1)	1,140	(1)
Per machine.....	2,168	(1)	2,293	(1)	668	(1)
Gas engines:						
Per station.....	190	121	209	131	109	64
Per machine.....	121	74	129	76	78	53
Water wheels:						
Per station.....	1,483	756	1,606	806	341	224
Per machine.....	544	315	566	327	198	137
Auxiliary engines:						
Per station.....	201	72	228	78	33	32
Per machine.....	78	40	83	41	21	23

¹ In 1902 steam turbines were included with steam engines.

CENTRAL ELECTRIC LIGHT AND POWER STATIONS.

Except for the comparatively unimportant auxiliary engines reported by municipal stations, in which there was a small decrease in horsepower per machine, there was in every instance a pronounced increase per station and per machine for the total, for all machines, and for each class of machine reported at both censuses. The smallest increase in total average capacity is shown for steam engines which, when compared with the large average power of the steam turbines, indicates that when great units of steam power have been required the steam turbine has been utilized. It is apparent, however, that since the figures for steam turbines were combined with those for steam engines in 1902 a correct understanding of the relative averages can be obtained only by the addition of the two sets of figures for 1907. The averages thus secured, for the totals of this combination, show that the increase in steam power has been on a par with that of the other kinds of primary power.

As might be expected, every class of machine reported by the commercial stations not only averaged much larger than those of the municipal stations but the increase in capacity also was greater.

The averages contained in Table 31 are based upon the horsepower as shown in Table 21, while the number of stations reporting the various kinds of power is shown in the following statement:

Commercial and municipal central electric stations—Distribution by number of stations, and kinds of primary power: 1907 and 1902.

KIND OF POWER.	Census.		Total.	Commer- cial.	Municipal.
	1907	1902			
Steam engines.....	1907 1902	3,704 3,100	2,606 2,356	1,098 744	
Steam turbines.....	1907 1902	187 (¹)	170 (¹)	17 (¹)	
Gas engines.....	1907 1902	294 101	238 86	56 15	
Water wheels.....	1907 1902	910 580	821 530	89 50	
Auxiliary engines.....	1907 1902	328 201	282 175	46 26	

¹ In 1902 steam turbines were included with steam engines.

A total of the number of stations in this statement would be in excess of the actual number reported, since a station having several kinds of power would be repeated under each class of power with which it was equipped.

Dynamos, central stations, and electric railways.—The electric-generating machines in the central stations and electric-railway plants represent the majority of those in use in the United States, and in order to show statistics for the aggregate the totals for the two branches of the industry are combined in Table 32.

TABLE 32.—CENTRAL ELECTRIC STATIONS AND ELECTRIC RAILWAYS—NUMBER AND KILOWATT CAPACITY OF DYNAMOS IN GENERATING STATIONS, BY KIND OF DYNAMO: 1907 AND 1902.

KIND OF DYNAMO.	TOTAL.		CENTRAL STATIONS.		ELECTRIC RAILWAYS.		PER CENT OF INCREASE.		
	1907	1902	1907	1902	1907	1902	Total.	Central stations.	Electric railways.
Total:									
Number.....	15,297	15,786	12,173	12,484	3,124	3,302	13.1	12.5	15.4
Kilowatt capacity.....	4,432,641	2,110,597	2,709,225	1,212,235	1,723,416	898,362	110.0	123.5	91.8
Direct-current, constant-voltage:									
Number.....	5,872	6,684	3,680	3,823	2,192	2,861	112.1	13.7	123.4
Kilowatt capacity.....	1,347,962	1,055,411	406,460	330,065	941,502	725,346	27.7	23.1	29.8
Direct-current, constant-amperage:									
Number.....	1,685	3,539	1,685	3,539	(²)	(²)	152.4	152.4	(²)
Kilowatt capacity.....	80,992	145,866	80,992	145,866	(²)	(²)	144.5	144.5	(²)
Alternating single-phase and polyphase current:									
Number.....	7,740	5,563	6,808	5,122	932	441	59.1	32.9	111.3
Kilowatt capacity.....	3,003,687	909,320	2,221,773	736,304	781,914	173,016	230.3	201.7	351.9

¹ Decrease.

² Not reported.

With the exception of the dynamos in the isolated electric plants and telephone and telegraph offices, which are comparatively unimportant, the equipment covered by this table may be accepted as representing all dynamos used for the generation of electricity for general commercial and municipal use.

The total dynamo capacity as reported for the combined industry increased 2,322,044 kilowatts, or 110 per cent, of which increase the central stations contributed 1,496,990 kilowatts, or 64.5 per cent, and the electric-railway plants 825,054 kilowatts, or 35.5 per cent. It is suggestive of the intimate relation existing between the electric generators and the pri-

mary power, the force necessary to operate the dynamo, that the percentage of increase of the primary power, 106.5 per cent, should so closely approximate that of the dynamos, which was 110 per cent. The evenness of these gains is somewhat remarkable, because both for primary power and for the generators the totals represent the equipment, all of which is not necessary for present requirements. That is, the primary power no doubt represents a larger horsepower than was actually required for electrical purposes at the time of the census, as in many instances plants were equipped to furnish power in connection with other industries conducted by the companies report-

ing, as well as with a view to future demands, emergency uses, etc. Similarly the total installation of dynamos represents not only the dynamos required to generate the current actually used, but includes those held in reserve to furnish additional current when needed and to provide for breakdowns or repairs.

Of the total number of dynamos reported, the proportion in central stations was practically the same at the two censuses, i. e., 79.6 per cent in 1907 and 79.1 per cent in 1902. The proportion of kilowatt capacity of the dynamos in the central stations increased, however, from 57.4 per cent in 1902 to 61.1 per cent in 1907.

The direct-current, constant-voltage dynamos showed a total increase in capacity of 292,551 kilowatts, or 27.7 per cent, the greater part of which increase, 216,156 kilowatts, or 73.9 per cent, was for electric railways, while but 76,395, or 26.1 per cent, was contributed by the central stations. Of the total kilowatt capacity of these machines, the electric-railway plants reported nearly seven-tenths in 1907 and a proportion but slightly smaller in 1902.

The direct-current, constant-amperage machine was not reported by the electric-railway plants, as it is not adapted to that service, and the uses of the machine are so restricted that comparatively few companies doing a general light and power business feel justified in carrying a class of dynamo only fitted for series arc lighting. The number of this class of dynamos reported by the central stations in 1907 was less than one-half the number so reported in 1902, and the decrease in their total capacity amounted to 64,874 kilowatts, or 44.5 per cent.

The alternating single-phase and polyphase current dynamo showed the largest actual and percentage of gain, due to the fact that it is adapted to almost every use required of a dynamo. The total capacity of these machines increased 2,094,367 kilowatts, or 230.3 per cent. Of this gain, 1,485,469 kilowatts, or 70.9 per cent, was represented by the central stations. Electric-railway plants reported a little more than one-fourth of the total capacity of these dynamos in 1907 and not quite one-fifth in 1902.

Table 33 shows the per cent distribution, by kind, of the dynamos in the central stations and electric-railway plants for 1902 and 1907.

Notwithstanding the increase of 27.7 per cent in the total capacity of the direct-current, constant-voltage dynamos in 1907, they represented only about three-tenths of the total capacity of all classes of dynamos in that year as compared with one-half of the total in 1902. The capacity of the alternating-current dynamos, which in 1902 represented but

little more than four-tenths of the total for all classes, had increased its proportion to more than two-thirds in 1907. The direct-current, constant-amperage dynamos, as already stated, were all reported by the central stations, and the small proportion which they supplied of the total kilowatt capacity decreased from nearly 7 per cent in 1902 to slightly less than 2 per cent in 1907.

TABLE 33.—Central electric stations and electric railways—Per cent distribution, by kind and by number and capacity of dynamos: 1907 and 1902.

KIND OF DYNAMO.	TOTAL.		CENTRAL STATIONS.		ELECTRIC RAILWAYS.	
	1907	1902	1907	1902	1907	1902
Total:						
Number.....	100.0	100.0	100.0	100.0	100.0	100.0
Kilowatt capacity...	100.0	100.0	100.0	100.0	100.0	100.0
Direct-current, constant-voltage:						
Number.....	38.4	42.3	30.2	30.6	70.2	86.6
Kilowatt capacity.....	30.4	50.0	15.0	27.2	54.6	80.7
Direct-current, constant-amperage:						
Number.....	11.0	22.4	13.8	23.3	(1)	(1)
Kilowatt capacity.....	1.8	6.9	3.0	12.0	(1)	(1)
Alternating single-phase and polyphase current:						
Number.....	50.6	35.2	55.9	41.0	29.8	13.4
Kilowatt capacity.....	67.8	43.1	82.0	60.7	45.4	19.3

¹ Not reported by electric railways.

Dynamos in central stations.—As compared with the total kilowatt capacity of all dynamos reported in 1902 there was an increase in 1907 of 1,496,990 kilowatts, or 123.5 per cent. Of this increase, the commercial stations reported 1,401,354 kilowatts, or 93.6 per cent, and the municipal stations only 95,636 kilowatts, or 6.4 per cent. In 1907 the commercial stations reported 92.3 per cent of the total dynamo capacity and the municipal stations 7.7 per cent. When compared with similar proportions for the prior census it is found that the percentage for the commercial stations was 1.7 per cent greater than in 1902.

The increase in the number and in the capacity of the dynamos of the different kinds in commercial and municipal stations is shown by the figures in Table 34, while Table 35 gives the per cent distribution of such dynamos, by kind, for 1907 and 1902.

The advantages possessed by the alternating-current dynamo and its adaptability for general central-station work is illustrated by the tremendous gain in its use. Practically the entire increase in dynamo capacity was due to the gain made by the alternating-current machine, as the direct-current, constant-amperage machines lost 64,874 in kilowatt capacity, which was but little more than counterbalanced by a gain of 76,395 kilowatts in the capacity of the direct-current, constant-voltage machines.

CENTRAL ELECTRIC LIGHT AND POWER STATIONS.

TABLE 34.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—NUMBER AND KILOWATT CAPACITY OF DYNAMOS IN GENERATING STATIONS, BY KIND OF DYNAMO: 1907 AND 1902.

KIND OF DYNAMO.	TOTAL.		COMMERCIAL.		MUNICIPAL.		PER CENT OF INCREASE.		
	1907	1902	1907	1902	1907	1902	Total.	Commer- cial.	Municipal.
Total:									
Number.....	12,173	12,484	9,778	10,662	2,395	1,822	12.5	18.3	31.4
Kilowatt capacity.....	2,709,225	1,212,235	2,500,209	1,098,855	209,016	113,380	123.5	127.5	84.3
Direct-current, constant-voltage:									
Number.....	3,680	3,823	3,169	3,405	511	418	13.7	16.0	22.2
Kilowatt capacity.....	406,460	330,065	379,706	312,509	26,754	17,556	23.1	21.5	52.4
Direct-current, constant-amperage:									
Number.....	1,685	3,539	1,246	2,957	439	582	152.4	157.9	124.6
Kilowatt capacity.....	80,992	145,866	61,753	117,695	19,239	28,171	144.5	147.5	131.7
Alternating single-phase and polyphase current:									
Number.....	6,808	5,122	5,363	4,300	1,445	822	32.9	24.7	75.8
Kilowatt capacity.....	2,221,773	736,304	2,058,750	684,651	163,023	67,653	201.7	207.9	141.0

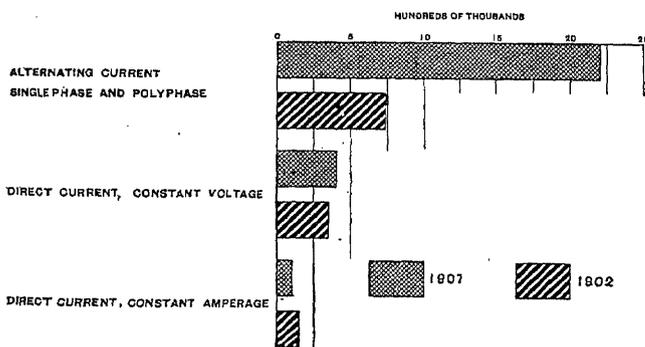
¹ Decrease.

Although the kilowatt capacity of the direct-current, constant-voltage dynamos had increased nearly one-fourth since 1902, the relative importance of these machines was considerably less in 1907. The number and capacity of the direct-current, constant-amperage dynamos has decreased since 1902, as has their relative importance.

TABLE 35.—Commercial and municipal central electric stations—Per cent distribution, by kind and by number and capacity of dynamos: 1907 and 1902.

KIND OF DYNAMO.	TOTAL.		COMMERCIAL.		MUNICIPAL.	
	1907	1902	1907	1902	1907	1902
Total:						
Number.....	100.0	100.0	100.0	100.0	100.0	100.0
Kilowatt capacity.....	100.0	100.0	100.0	100.0	100.0	100.0
Direct-current, constant-voltage:						
Number.....	30.2	30.6	32.4	31.9	21.3	22.9
Kilowatt capacity.....	15.0	27.2	15.2	28.4	12.8	15.5
Direct-current, constant-amperage:						
Number.....	13.8	28.3	12.7	27.7	18.3	31.9
Kilowatt capacity.....	3.0	12.0	2.5	10.7	9.2	24.8
Alternating single-phase and polyphase current:						
Number.....	55.9	41.0	54.8	40.3	69.3	45.1
Kilowatt capacity.....	82.0	60.7	82.3	60.8	78.0	59.7

DIAGRAM 5.—Central electric stations—Capacity of dynamos: 1907 and 1902.



The average capacity of the different types of dynamos per station and per machine for commercial and municipal stations, 1907 and 1902, is shown in Table 36.

TABLE 36.—Commercial and municipal central electric stations—Average kilowatt capacity of dynamos, by kind, per station, and per machine: 1907 and 1902.

KIND OF DYNAMO.	TOTAL.		COMMERCIAL.		MUNICIPAL.	
	1907	1902	1907	1902	1907	1902
Total kilowatt capacity:						
Per station.....	575	335	722	392	167	139
Per machine.....	223	97	256	163	87	62
Direct-current, constant-voltage:						
Per station.....	256	228	298	262	85	70
Per machine.....	110	86	120	92	52	42
Direct-current, constant-amperage:						
Per station.....	149	126	181	136	96	95
Per machine.....	48	41	50	40	44	48
Alternating single-phase and polyphase current:						
Per station.....	645	280	816	323	177	120
Per machine.....	326	144	384	156	113	82

The average capacity of the several classes of dynamos, per station and per machine, was determined from the number of these machines as shown in Table 34, and the number of stations reporting the different types of dynamos is shown in the following statement:

Commercial and municipal central electric stations—Number of stations, by kind of dynamo: 1907 and 1902.

KIND OF DYNAMO.	Census.	Total.	Commer- cial.	Municipal.
Direct-current, constant-voltage.....	1907	1,588	1,273	315
	1902	1,447	1,195	252
Direct-current, constant-amperage.....	1907	542	342	200
	1902	1,169	864	296
Alternating single-phase and polyphase current.	1907	3,446	2,524	922
	1902	2,634	2,069	565

The increase in the total average capacity of the dynamos per station and per machine, shown in Table 36, is in keeping with the general tendency toward larger units of equipment in almost all branches of central-station work.

For the direct-current dynamos there was an increase, although not very pronounced, both per station and per machine. The constant-amperage dynamos in the municipal stations form the single exception to an increase, the average capacity of these dynamos showing a decrease per machine from 48 to 44 kilo-

watts. There has been a large decrease in the number of this latter class of dynamos and probably but few new ones installed, and the figures indicate that those removed have been the machines of the larger capacity. In harmony with the great increase in the kilowatt capacity shown for the alternating-current dynamo in other tables, the table of average capacity shows an increase in every detail presented.

A better understanding of the dynamo equipment of central stations may be obtained from a study of the detailed statistics showing the number and capacity of the different types of machines, grouped according to size. The totals for the United States are summarized in Table 37.

TABLE 37.—Central electric stations—Kind of dynamos, by class, number, and kilowatt capacity: 1907.

CLASS OF DYNAMO.	Total.	Direct-current, constant-voltage.	Direct-current, constant-amperage.	Alternating single-phase and poly-phase current.
Total:				
Number.....	12,173	3,680	1,685	6,808
Kilowatt capacity.....	2,709,225	406,460	80,992	2,221,773
Under 200 kilowatt capacity:				
Number.....	9,491	3,128	1,664	4,699
Kilowatt capacity.....	664,440	183,865	71,649	408,926
Per cent of total kilowatt capacity.....	24.5	45.2	88.5	18.4
200 but under 500 kilowatt capacity:				
Number.....	1,547	417	16	1,114
Kilowatt capacity.....	434,586	115,155	4,833	314,598
Per cent of total kilowatt capacity.....	16.0	28.3	6.0	14.2
500 but under 1,000 kilowatt capacity:				
Number.....	624	102	3	519
Kilowatt capacity.....	390,149	63,890	2,010	324,249
Per cent of total kilowatt capacity.....	14.4	15.7	2.5	14.6
1,000 but under 2,000 kilowatt capacity:				
Number.....	281	30	2	249
Kilowatt capacity.....	351,700	36,550	2,500	312,650
Per cent of total kilowatt capacity.....	13.0	9.0	3.1	14.1
2,000 but under 5,000 kilowatt capacity:				
Number.....	163	3	.....	160
Kilowatt capacity.....	438,350	7,000	.....	431,350
Per cent of total kilowatt capacity.....	16.2	1.7	.....	19.4
5,000 kilowatt capacity and over:				
Number.....	67	.....	.....	67
Kilowatt capacity.....	430,000	.....	.....	430,000
Per cent of total kilowatt capacity.....	15.9	.....	.....	19.4

Of the direct-current, constant-voltage dynamo capacity, 73.5 per cent was represented by the machines of less than 500 kilowatts; 24.7 per cent by those in the two classes 500 but under 2,000 kilowatt capacity; only 1.7 per cent by those in the class "2,000 but under 5,000 kilowatt capacity;" and none in the class "5,000 kilowatt capacity and over."

The direct-current, constant-amperage machines show even a larger proportion in the small classes, the class of "under 200 kilowatt capacity" having 88.5 per cent, with small proportions in the next three classes and no dynamo of this type of 2,000 kilowatt capacity or over.

The remarkable increase in the use of the alternating-current dynamo has already been shown, and its adaptability to the varying requirements as to capacity are demonstrated by the evenness of its distribution among the several classes, the variation in the propor-

tion of the six classes ranging from only 14.1 per cent for the class of the lowest total capacity to 19.4 for the class of the highest. Beginning with the class with the smallest kilowatt capacity, the proportions of the total capacity for all kinds of dynamos contributed by the alternating-current were as follows: 61.5; 72.4; 83.1; 88.9; 98.4; and 100 per cent, the proportion thus steadily increasing with the capacity of the dynamo.

In Table 38 the dynamos in commercial and municipal stations, respectively, have been grouped according to the capacity of the separate machines.

TABLE 38.—Commercial and municipal central electric stations—Dynamos, by number and kilowatt capacity: 1907.

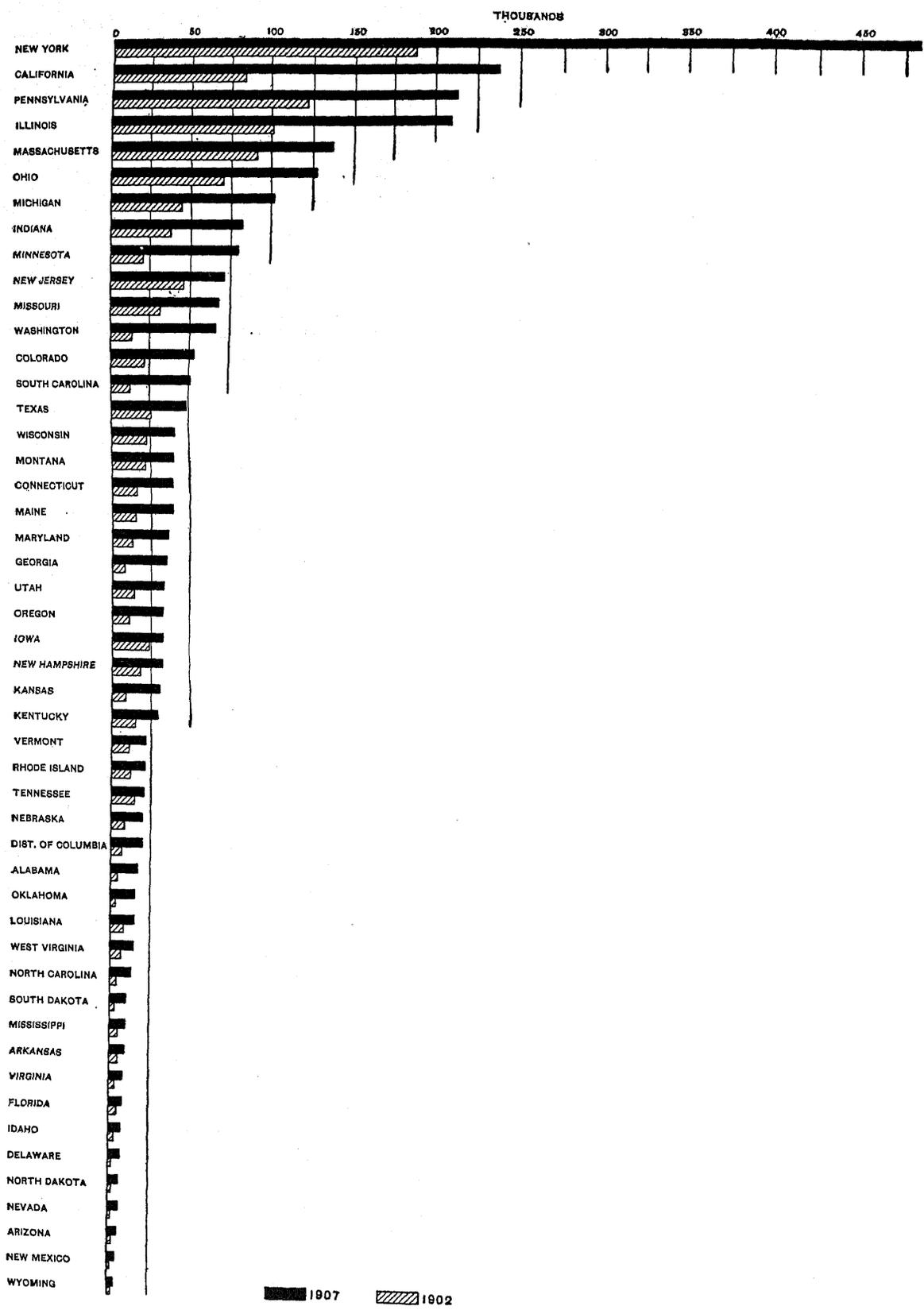
CLASS OF DYNAMO.	Total.	Commercial.	Municipal.
Total:			
Number.....	12,173	9,778	2,395
Kilowatt capacity.....	2,709,225	2,500,209	209,016
Under 200 kilowatt capacity:			
Number.....	9,491	7,283	2,208
Kilowatt capacity.....	664,440	513,427	151,013
200 but under 500 kilowatt capacity:			
Number.....	1,547	1,375	172
Kilowatt capacity.....	434,586	389,833	44,753
500 but under 1,000 kilowatt capacity:			
Number.....	624	613	11
Kilowatt capacity.....	390,149	383,699	6,450
1,000 but under 2,000 kilowatt capacity:			
Number.....	281	278	3
Kilowatt capacity.....	351,700	346,900	4,800
2,000 but under 5,000 kilowatt capacity:			
Number.....	163	162	1
Kilowatt capacity.....	438,350	436,350	2,000
5,000 kilowatt capacity and over:			
Number.....	67	67	.....
Kilowatt capacity.....	430,000	430,000	.....

This table shows in every class not only the great preponderance of the dynamo capacity of commercial over municipal stations, but also the little use of dynamos of large capacity in the municipal stations.

The increase in dynamo capacity is practically confined to the states for which statistics are given in Table 39.

The total increase in the dynamo capacity of these 21 states, each of which made a gain of over 20,000 kilowatts, amounted to 1,256,929 kilowatts, or 84 per cent of the total increase for the entire United States. To illustrate the extent to which single-phase and poly-phase dynamos have superseded the other varieties of machines, the increase in their kilowatt capacity is shown separately and is found to approximate closely the total increase for all machines, the difference for the selected states being but 2,361 kilowatts, or less than two-tenths of 1 per cent, and that for the entire United States 11,521 kilowatts, or about eight-tenths of 1 per cent. In some states the increase in the capacity of the alternating-current machines exceeds that for all classes of dynamos; due to the fact that there was an actual decrease in the capacity of the direct-current machines in several states.

DIAGRAM 6.—CENTRAL ELECTRIC STATIONS—CAPACITY OF DYNAMOS, BY STATES, ARRANGED IN THE ORDER OF THEIR RELATIVE IMPORTANCE: 1907 AND 1902.



In each of 8 states—California, Illinois, Michigan, Minnesota, New York, Ohio, Pennsylvania, and Washington—the increase in the capacity of dynamos exceeded 50,000 kilowatts. The total increase in these states amounted to 873,910, or 58.4 per cent of the

total gain for the United States. In 3 states—California, Illinois, and New York—the dynamo capacity increased more than 100,000 kilowatts each, the total amounting to 558,349 kilowatts, or 37.3 per cent of the total gain for all stations.

TABLE 39.—CENTRAL ELECTRIC STATIONS—KILOWATT CAPACITY OF DYNAMOS IN THE STATES WHICH INCREASED THEIR CAPACITY OVER 20,000 KILOWATTS: 1907 AND 1902.

STATE.	KILOWATT CAPACITY.					
	Total.		Actual increase.	Per cent of increase.	Per cent distribution of increase.	Actual increase in capacity of alternating single-phase and poly-phase current dynamos.
	1907	1902				
Total for United States.....	2,709,225	1,212,235	1,496,990	123.5	100.0	1,485,469
Total for selected states.....	2,238,059	981,130	1,256,929	128.1	84.0	1,254,568
California.....	238,480	83,816	154,664	184.5	10.3	161,830
Colorado.....	53,130	21,808	31,322	143.6	2.1	32,423
Connecticut.....	39,363	15,516	23,847	153.7	1.6	21,221
Georgia.....	35,446	7,620	27,826	365.2	1.9	27,595
Illinois.....	209,226	100,320	108,906	108.6	7.3	115,873
Indiana.....	81,576	38,144	43,432	113.9	2.9	41,104
Kansas.....	30,307	8,596	21,711	252.6	1.5	18,320
Maine.....	39,290	15,291	23,999	156.9	1.6	22,158
Maryland.....	36,223	13,207	23,016	174.3	1.5	24,105
Massachusetts.....	135,924	90,624	45,300	50.0	3.0	53,993
Michigan.....	101,714	44,176	57,538	130.2	3.8	60,492
Minnesota.....	78,516	20,999	57,517	273.9	3.8	52,496
Missouri.....	68,467	32,100	36,367	113.3	2.4	39,318
New Jersey.....	70,566	46,120	24,446	53.0	1.6	20,316
New York.....	482,031	187,252	294,779	157.4	19.7	295,359
Ohio.....	126,533	69,811	56,722	81.3	3.8	58,050
Oregon.....	32,587	11,165	21,422	191.9	1.4	19,325
Pennsylvania.....	212,543	121,388	91,155	75.1	6.1	82,198
South Carolina.....	51,271	13,390	37,881	282.9	2.5	38,370
Texas.....	48,558	26,108	22,450	86.0	1.5	17,853
Washington.....	66,308	13,679	52,629	384.7	3.5	52,164
All other states.....	471,160	231,105	240,061	103.9	16.0	230,901

In addition to the dynamos, the number and capacity of the auxiliary machines used in connection with the distribution of the electric energy were reported, and the statistics for them are summarized in Table 40.

TABLE 40.—Commercial and municipal central electric stations—Number and kilowatt capacity of miscellaneous main-station equipment: 1907 and 1902

KIND OF EQUIPMENT.	Census.	TOTAL.		COMMERCIAL.		MUNICIPAL.	
		Number.	Kilowatt capacity.	Number.	Kilowatt capacity.	Number.	Kilowatt capacity.
Transformers ¹	1907	1,577	592,708	1,432	587,421	145	5,287
Rotaries.....	1907	180	52,416	175	51,703	5	713
	1902	132	47,608	131	47,508	1	100
Boosters.....	1907	127	4,810	106	4,474	21	336
	1902	193	13,361	184	13,230	9	131
Storage-battery cells...	1907	9,751	.....	9,255	.....	496	.....
	1902	6,881	.....	5,981	.....	900	.....
Miscellaneous ²	1907	.....	43,209	.....	42,256	.....	953

¹ Not reported as main-station equipment in 1902.

² Includes motor generators, motors, regulators, and other accessories. Not reported as main-station equipment in 1902.

The transformers in the main station, which are chiefly those used to raise the voltage generated for purposes of transmission, and miscellaneous machines were not called for in 1902 as connected with the generating plant; hence the extent of their use at

that census can not be determined. The transformers probably were reliably reported, but it was apparent from an examination of the reports that there was little uniformity among the electric companies in reporting their miscellaneous machines. The commercial stations, which reported most of the boosters, show a decided decrease in these machines in 1907, which is in harmony with the later dynamo equipment and more recent methods followed in central-station management.

The substation equipment, as reported at the two censuses, is shown in Table 41.

TABLE 41.—Commercial and municipal central electric stations—Number and kilowatt capacity of substation equipment, by kind: 1907 and 1902.

KIND OF EQUIPMENT.	Census.	TOTAL.		COMMERCIAL.		MUNICIPAL.	
		Number.	Kilowatt capacity.	Number.	Kilowatt capacity.	Number.	Kilowatt capacity.
Transformers.....	1907	4,211	1,100,824	4,047	1,090,261	164	10,563
	1902	1,800	312,848	1,765	311,879	35	969
Rotaries.....	1907	490	311,003	490	311,003	.....	.....
	1902	169	31,728	168	31,721	1	7
Storage-battery cells.....	1907	20,187	.....	20,187	.....	.....	.....
	1902	8,388	.....	8,388	.....	.....	.....
Miscellaneous ¹	1907	.....	99,275	.....	98,117	.....	1,168
	1902	.....	15,997	.....	15,867	.....	130

¹ Includes motor generators, motors, regulators, and other accessories.

It is evident that the electric service performed by the municipal stations was of a character which necessitated a very limited use of substations. Of the 1,093 substations reported for all central stations, only 57 were connected with municipal stations, and practically their entire equipment was confined to a few step-down transformers.

OUTPUT OF STATIONS.

The product of central electric stations is electrical energy or current and the operations of such stations are measured by this output in kilowatt hours. Accordingly, as in 1902, an inquiry with respect to the total output of current for the year in kilowatt hours was made a part of the schedule. With many establishments, the output is a matter of scientific accounting, being carefully recorded from the actual watt-hour or kilowatt-hour readings of dynamo meters. Many other establishments, however, particularly the smaller plants, could give no exact data in reply to this inquiry, but were asked to make careful estimates. There is thus a considerable element of estimate in the figures, but it is believed that it is not sufficiently large to vitiate or to impair seriously their statistical value.

TABLE 42.—Central electric stations and electric railways—Output of generating stations: 1907 and 1902.

	KILOWATT HOURS.		Per cent of increase.
	1907	1902	
Total.....	10,621,406,837	4,768,535,512	122.7
Central stations.....	5,862,276,737	2,507,051,115	133.8
Electric railways.....	4,759,130,100	2,261,484,397	110.4

There were 10,621,406,837 kilowatt hours of current generated in central stations and electric-railway plants in 1907 compared with 4,768,535,512 in 1902, an increase of 122.7 per cent. Central stations reported 55.2 per cent of the total output in 1907 as compared with 52.6 per cent in 1902.

It is interesting to compare the total kilowatt capacity of dynamos with the annual output of current. Confining this comparison to central stations, the total kilowatt-hour capacity of such stations in 1907 was reported as 2,709,225, and the annual output was 5,862,276,737 kilowatt hours. Assuming that the stations could be operated continuously twenty-four hours a day for 365 days, or one year, at their maximum capacity, the theoretical annual capacity would be 23,732,811,000 kilowatt hours; the actual output, however, was only 24.7 per cent, or less than one-fourth, of this amount. The corresponding percentage at the census of 1902 was 23.6. As illustrating the same point, a division of the kilowatt capacity of the dynamos into the output for the year gives, theoretically, the number of hours of operation of the generators on the basis of their maximum capacity.

The figures, thus derived, 2,164 for 1907 and 2,068 for 1902, when compared with the total number of hours in a year of 365 days, 8,760, show in another way the difference between the theoretical maximum capacity and the actual conditions as reported. There are, however, several circumstances which lessen the value of such comparisons. The indicated capacity of a dynamo is the theoretical maximum capacity or greatest load at which it can be operated. It is mechanically impossible, of course, to operate dynamos or other machinery at maximum capacity for any length of time, and the necessity for repairs frequently puts the generating machinery wholly out of commission. Many central stations, especially those of large capacity, have installed duplicate machines to provide against accident, and thus throughout the year a considerable part of their equipment is idle. Again, to render satisfactory service to the consumers, a station should be equipped to transmit sufficient current to satisfy the largest possible demand. Therefore as the consumption varies from the peak of the load capacity to a small fraction of it the speed of the dynamos is moderated, or some of them are stopped altogether, in accordance with the requirements. A large proportion of the smaller plants operate only during the hours of darkness, and many during the few hours from sunset to midnight. These and other factors, therefore, combine to explain the difference, previously noted, between the actual output of the central-station dynamos and the output which they are theoretically capable of generating.

The income received during the year 1907 by central stations from the sale of current amounted to \$169,614,691; the total output of stations was 5,862,276,737 kilowatt hours; the average earnings per kilowatt hour therefore appear to have been about $2\frac{9}{10}$ cents, compared with $3\frac{4}{10}$ cents in 1902. Improved methods of transmission in 1907 over 1902, resulting in a decreased loss of current, the large increase in the average capacity of the generating units, and economies in other directions, have no doubt reduced the cost of production and thus make possible the delivery of current at a lower figure.

A comparison of the output of commercial and municipal stations reveals the comparative unimportance of the latter in that respect.

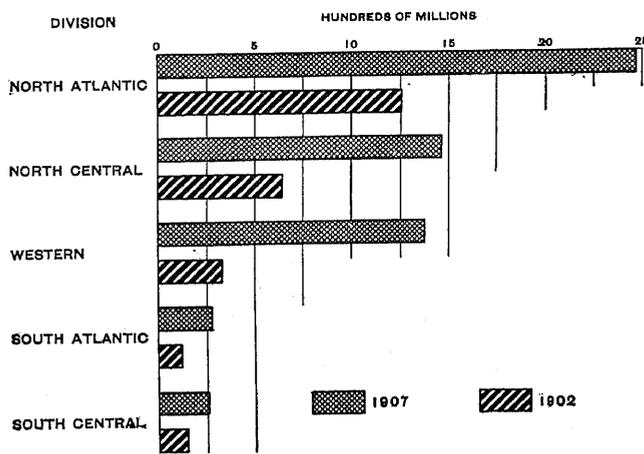
TABLE 43.—Commercial and municipal central electric stations—Output of generating stations: 1907 and 1902.

	KILOWATT HOURS.		Per cent of increase.
	1907	1902	
Total.....	5,862,276,737	2,507,051,115	133.8
Commercial.....	5,572,813,049	2,311,146,676	141.1
Municipal.....	289,462,788	195,904,439	47.8

From 1902 to 1907 the output of municipal stations increased only 47.8 per cent, while the output of commercial stations increased 141.1 per cent. The greater importance of commercial stations is still further shown in the fact that the percentage which their output formed of the total for all central stations increased from 92.2 in 1902 to 95.1 in 1907, while as a necessary sequence the proportion of municipal stations dropped from 7.8 per cent to 4.9 per cent.

The increase in output of electric current is an accurate measure of the increase in importance of the central stations in other particulars—investment, equipment, etc. The accompanying diagram shows the output for each geographic division for 1907 and 1902.

DIAGRAM 7.—Central electric stations—Output, by geographic divisions: 1907 and 1902.



The following table illustrates the differences which mark the rate of development of the use of electric current for light and power in the several states. The output in every state shows an increase in 1907 over 1902. The largest actual increase is shown for New York, with California, Illinois, Washington, Pennsylvania, Michigan, and Montana following in the order named, each with an increase of more than 100,000,000 kilowatt hours. On the other hand the states which

show the largest percentages of increase are Nevada, Washington, Oklahoma, Georgia, Oregon, Kansas, and California, in the order given, each with an increase exceeding 300 per cent. The smallest increase in both amount and per cent was for Iowa.

TABLE 44.—Central electric stations—Output of generating stations, by states and territories, with per cent of increase and per cent distribution of total increase: 1907 and 1902.

STATE OR TERRITORY.	OUTPUT OF STATIONS (KILOWATT HOURS).				
	1907	1902	Actual increase.	Per cent of increase.	Per cent distribution of increase.
United States...	5,862,276,737	2,507,051,115	3,355,225,622	133.8	100.0
Alabama.....	30,846,764	11,616,707	19,230,057	165.5	0.6
Arizona.....	9,392,302	3,662,045	5,730,257	156.5	0.2
Arkansas.....	11,519,316	9,965,997	1,553,319	15.6	(1)
California.....	661,606,309	152,728,042	508,878,267	333.2	15.2
Colorado.....	123,275,212	60,177,084	63,098,128	104.9	1.9
Connecticut.....	67,408,232	26,738,121	40,668,111	152.1	1.2
Delaware and District of Columbia.....	30,543,522	17,871,872	12,671,650	70.9	0.4
Florida.....	11,765,994	8,066,078	3,699,916	45.9	0.1
Georgia.....	59,311,202	9,911,243	49,399,959	498.4	1.5
Idaho.....	9,577,588	6,018,149	4,559,439	90.9	0.1
Illinois.....	467,657,328	161,543,646	306,113,682	189.5	9.1
Indiana.....	130,273,692	75,585,493	54,678,200	72.3	1.6
Iowa.....	37,729,072	36,506,425	1,222,647	3.3	(1)
Kansas.....	59,740,179	13,326,518	46,413,661	348.3	1.4
Kentucky.....	37,232,623	27,835,614	9,397,009	33.8	0.3
Louisiana.....	26,421,316	17,474,261	8,947,055	51.2	0.3
Maine.....	66,136,651	21,987,700	44,148,951	200.8	1.3
Maryland.....	47,868,675	22,128,125	25,740,550	116.3	0.8
Massachusetts.....	219,425,607	125,813,392	93,612,215	74.4	2.8
Michigan.....	208,154,199	80,564,630	127,589,569	158.4	3.8
Minnesota.....	87,579,431	40,258,632	47,320,799	117.5	1.4
Mississippi.....	15,704,624	9,825,926	5,878,698	59.8	0.2
Missouri.....	147,328,446	57,450,731	89,877,715	156.4	2.7
Montana.....	137,379,261	36,435,766	100,943,495	277.0	3.0
Nebraska.....	31,958,739	12,315,775	19,642,964	159.5	0.6
Nevada.....	29,621,730	1,508,910	28,112,820	1,863.1	0.8
New Hampshire.....	55,258,921	27,377,793	27,881,128	101.8	0.8
New Jersey.....	140,527,522	78,739,456	61,788,066	78.5	1.8
New Mexico.....	4,614,349	2,637,810	1,976,539	74.9	0.1
New York.....	1,452,222,471	701,769,716	750,452,755	106.9	22.4
North Carolina.....	13,171,681	8,351,346	4,820,335	57.7	0.1
North Dakota.....	8,229,765	5,850,115	2,379,650	40.5	2.7
Ohio.....	217,311,924	127,437,383	89,874,541	70.5	0.6
Oklahoma.....	24,985,903	3,825,763	21,160,140	553.1	2.2
Oregon.....	92,807,992	17,531,660	75,276,332	429.4	2.2
Pennsylvania.....	416,554,167	241,094,928	175,459,239	72.8	5.2
Rhode Island.....	35,651,323	23,436,435	12,214,888	52.1	0.4
South Carolina.....	68,696,424	15,426,763	50,269,661	272.8	1.5
South Dakota.....	13,615,015	4,256,007	9,359,008	219.9	0.3
Tennessee.....	34,847,956	24,472,632	10,375,324	42.4	0.3
Texas.....	75,829,108	48,888,450	26,940,658	55.1	0.8
Utah.....	61,672,661	32,457,063	29,215,598	90.0	0.9
Vermont.....	29,923,333	22,374,000	7,549,273	33.7	0.2
Virginia.....	10,208,300	6,879,243	3,329,117	48.4	0.1
Washington.....	257,785,236	19,722,262	238,062,974	1,207.1	7.1
West Virginia.....	24,871,317	11,555,905	13,315,412	119.0	0.4
Wisconsin.....	52,546,210	29,906,758	22,679,452	75.3	0.7
Wyoming.....	5,499,084	3,883,285	1,615,799	41.6	(1)

¹ Less than one-tenth of 1 per cent.

CHAPTER IV.

LINE EQUIPMENT.

Central stations and electric railways.—The prevalence of the lighting and general motor service among the electric-railway companies makes it necessary to combine their equipment with that of the central stations

in order to show the total number of lamps, meters, transformers, and stationary motors wired for service. Such totals are given in Table 45.

TABLE 45.—CENTRAL ELECTRIC STATIONS AND ELECTRIC RAILWAYS—LAMPS, METERS, TRANSFORMERS IN CIRCUITS, AND STATIONARY MOTORS: 1907 AND 1902.

	TOTAL.		CENTRAL STATIONS.		ELECTRIC RAILWAYS.		PER CENT OF INCREASE.		
	1907	1902	1907	1902	1907	1902	Total.	Central stations.	Electric railways.
Arc lamps.....	635,815	419,561	555,713	385,698	80,102	33,863	51.5	44.1	136.5
Public.....	318,819	229,403	289,301	211,725	29,428	17,678	39.0	36.7	66.5
Commercial.....	316,996	190,158	266,322	173,973	50,674	16,185	66.7	53.1	213.1
Incandescent lamps.....	45,991,836	19,636,729	41,445,997	18,194,044	4,545,839	1,442,685	134.2	127.8	215.1
Public.....	866,851	474,686	808,693	455,660	58,158	19,026	82.6	77.5	205.7
Commercial.....	45,124,985	19,162,043	40,637,304	17,738,384	4,487,681	1,423,659	135.5	129.1	215.2
Other varieties of lamps—Nernst, vacuum, vapor, etc.....	190,979	(1)	162,338	(1)	28,641	(1)	.....	.....	.....
Public.....	6,090	(1)	5,716	(1)	374	(1)	.....	.....	.....
Commercial.....	184,889	(1)	156,622	(1)	28,267	(1)	.....	.....	.....
Lamps used by the central stations to light their own electric properties.....	1,107,116	(1)	275,079	(1)	832,037	(1)	.....	.....	.....
Meters on consumption circuits.....	1,897,803	639,290	1,683,917	582,689	213,886	56,601	196.9	189.0	277.9
Transformers in circuits for customers:									
Number.....	299,489	207,370	299,489	207,370	(2)	(2)	44.4	44.4	.....
Kilowatt capacity.....	2,058,567	687,121	2,058,567	687,121	(2)	(2)	199.6	199.6	.....
Stationary motors: ³									
Number.....	187,652	111,113	167,184	101,064	20,468	10,049	68.9	65.4	103.7
Horsepower.....	1,807,949	473,693	1,649,026	438,005	158,923	35,688	281.7	276.5	345.3

¹ Not reported separately.

² Not called for in schedule for electric railways.

³ Some fan motors were included in 1902, but such motors were omitted in 1907.

The apparatus represented by the statistics in this table is characteristic of central-station work, and although a considerable proportion is connected with railway plants, it all belongs to the same department of industry. For the two branches of service together an aggregate of 47,925,746 lamps is shown for 1907 as compared with 20,056,290 for 1902, the increase amounting to 27,869,456, or 139 per cent. Of the total number of lamps, the central stations reported 88.6 per cent in 1907 and 92.6 per cent in 1902, and the electric railways, 11.4 per cent in 1907 and 7.4 per cent in 1902. In 1902 the railways reported 8.1 per cent of the arc lamps and 7.3 per cent of the incandescent lamps; at the census of 1907 these proportions had increased to 12.6 and 9.9 per cent, respectively.

Large increases are shown for all of the items of equipment, and in every instance the percentage of increase was much larger for the electric-railway plants than for the central stations. Several causes contribute to this condition, among which may be mentioned the method of preparing the reports when a central station and electric-railway plant are united and keep only one system of accounts. The tendency toward such combination in the interest of economy has been very general, and when separate reports

for the two branches could not be furnished, the combined industry was returned as an electric railway rather than as a central station, irrespective of the relative importance of the two branches.

The electric-railway branch of the characteristic central-station industry is, however, of very minor importance, comparatively, and the large percentages of increase in its apparatus have little effect on the increases shown for the total apparatus used in furnishing electric light and power.

CENTRAL STATIONS.

Lamps, meters, transformers, and stationary motors.—The lamps used for lighting streets, parks, public buildings, and all other public places for the illumination of which the municipality or other local government was responsible, were considered as devoted to the "public service," and were reported separately from those used in general "commercial service" in lighting residences, places of business, etc., for which individuals or private enterprises were responsible. The number of lamps for these two branches of service are shown in Table 46, which presents also data concerning the meters, transformers, and motors.

TABLE 46.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—LAMPS, METERS, TRANSFORMERS IN CIRCUITS, AND STATIONARY MOTORS: 1907 AND 1902.

	TOTAL.		COMMERCIAL.		MUNICIPAL.		PER CENT OF INCREASE.		
	1907	1902	1907	1902	1907	1902	Total.	Commer- cial.	Municipal.
Arc lamps.....	555,713	385,698	472,773	334,903	82,940	50,795	44.1	41.2	63.3
Public.....	289,391	211,725	216,309	166,723	73,082	45,002	36.7	29.7	62.4
Commercial.....	266,322	173,973	256,464	168,180	9,858	5,793	53.1	52.5	70.2
Incandescent lamps.....	41,445,997	18,194,044	37,393,549	16,616,593	4,052,448	1,577,451	127.8	125.0	156.9
Public.....	808,693	455,660	638,456	372,740	170,237	82,920	77.5	71.3	105.3
Commercial.....	40,637,304	17,738,384	36,755,093	16,243,853	3,882,211	1,494,531	129.1	126.3	159.8
Other varieties of lamps—Nernst, vacuum, vapor, etc.....	162,338	(1)	153,468	(1)	8,870	(1)			
Public.....	5,716	(1)	4,584	(1)	1,132	(1)			
Commercial.....	156,622	(1)	148,884	(1)	7,738	(1)			
Lamps used by the central stations to light their own electric properties.....	275,079	(1)	245,905	(1)	29,174	(1)			
Arc.....	7,082	(1)	6,487	(1)	595	(1)			
Incandescent.....	266,242	(1)	237,729	(1)	28,513	(1)			
All other lamps.....	1,755	(1)	1,689	(1)	66	(1)			
Meters on consumption circuits.....	1,683,917	582,689	1,468,763	526,011	215,154	56,678	189.0	179.2	279.6
Transformers in circuits for customers:									
Number.....	299,489	207,370	255,337	179,300	44,152	28,070	44.4	42.4	57.3
Kilowatt capacity.....	2,058,867	687,121	1,897,170	612,442	161,397	74,079	199.6	209.8	116.1
Stationary motors: ²									
Number.....	167,184	101,064	162,677	99,102	4,507	1,962	65.4	64.2	129.7
Horsepower.....	1,649,026	438,005	1,617,337	434,681	31,089	3,324	276.5	272.1	853.3

¹ Not reported separately.

² Some fan motors were included in 1902, but such motors were omitted in 1907.

Although every item of equipment specified in the table shows a large increase in 1907 as compared with 1902, the most notable increases and those indicating most nearly the progress in the industry are those for incandescent lamps, stationary motors, meters on consumption circuits, and transformers in circuits for customers. The number of incandescent lamps is necessarily, to some extent, an estimate. Accepting these estimates, there were 42,439,127 lamps of all varieties

connected with the central stations at the close of 1907 and 18,579,742 at the close of 1902, the increase for the five years amounting to 23,859,385 lamps, or 128.4 per cent. While this increase in the aggregate number of lamps indicates the development, a clearer understanding of the conditions will be obtained by an analysis of the statistics for the different varieties.

Arc lamps.—The statistics for the arc lamps are shown in Table 47.

TABLE 47.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—ARC LAMPS, BY KINDS: 1907 AND 1902.

KIND.	TOTAL.		COMMERCIAL.		MUNICIPAL.		PER CENT OF INCREASE.		
	1907	1902	1907	1902	1907	1902	Total.	Commer- cial.	Municipal.
Total.....	1,555,713	385,698	472,773	334,903	82,940	50,795	44.1	41.2	63.3
Open arcs.....	78,886	181,672	60,456	149,704	18,430	31,968	256.6	259.6	242.3
Public.....	66,879	138,684	48,875	108,082	18,004	30,602	251.8	254.8	241.2
Direct-current.....	64,416	134,054	47,207	105,401	17,209	28,653	251.9	255.2	239.9
Alternating-current.....	2,463	4,630	1,668	2,681	795	1,949	246.8	237.8	259.2
Commercial.....	12,007	42,988	11,581	41,622	426	1,366	272.1	272.2	268.8
Direct-current.....	10,050	39,255	9,696	37,091	354	1,264	274.4	274.5	272.0
Alternating-current.....	1,957	3,733	1,885	3,531	72	102	247.6	248.1	229.4
Inclosed arcs.....	476,827	204,026	412,317	185,199	64,510	18,827	133.7	122.6	242.6
Public.....	222,512	73,041	167,434	58,641	55,078	14,400	204.6	185.5	282.5
Direct-current.....	68,500	29,008	54,066	23,006	14,434	6,602	131.4	135.0	118.6
Alternating-current.....	154,012	43,433	113,368	35,635	40,644	7,798	254.6	218.1	421.2
Commercial.....	254,315	130,985	244,883	126,558	9,432	4,427	94.2	93.5	113.1
Direct-current.....	126,251	67,180	125,150	66,104	1,101	1,076	87.9	89.3	2.3
Alternating-current.....	128,064	63,805	119,733	60,454	8,331	3,351	100.7	98.1	148.6

¹ Exclusive of 7,082 lamps used by the central stations to light their own electric properties.

² Decrease.

Notwithstanding a considerable increase in the total number of arc lamps—170,015, or 44.1 per cent—the gain has been at a slower rate than that for incandescent lamps. At the census of 1902 the arc lamp had reached a higher degree of development than the incandescent lamp, since in the early stages of the industry

the demand for electricity was to a considerable extent influenced by its utility for street lighting, a branch of service which was at first confined to arc lamps. Now, however, the incandescent lamp has largely superseded the arc lamp for street and other lighting purposes, since it has been found that better service is secured

by the distribution of a larger number of comparatively small lamps than by the use of a few lamps of large candlepower. In fact, the relatively small gain in arc lamps may be accounted for by the much greater general usefulness of the incandescent lamp. The percentage of increase in the number of arc lamps was somewhat larger for the municipal than for the commercial stations. Inasmuch, however, as the total number of these lamps in municipal stations formed less than one-seventh of the total number in both branches of the service in 1902, and but little more than one-seventh in 1907, the percentage of gain is not of so much real significance. In this connection it may be of interest to note that, although at both censuses the municipal stations had a larger proportion of the total number of arc lamps than of the total number of incandescent lamps, the percentages being 14.9 for the former class and 9.8 for the latter in 1907, and 13.2 and 8.7 for the two classes, respectively, in 1902, the gains in the percentages were remarkably close, being 1.7 for the arc lamps and 1.1 for the incandescent lamps.

Since the census of 1902 the change then going on from the open arc to the inclosed has continued on a large scale. At that census the open-arc lamps which were of very limited length of continuous burning represented 47.1 per cent of the total number of

arcs, but in 1907 the proportion had declined to 14.2 per cent. There was an actual decrease in the number of open-arc lamps of 102,786, or 56.6 per cent, and an increase in the number of inclosed-arc lamps of 272,801, or 133.7 per cent. These figures show conclusively that not only is the inclosed arc demanded in new work, but that the old equipment of open arcs has largely been replaced by the inclosed lamp. In 1902 of the open arcs reported 82.4 per cent were in commercial stations and 17.6 per cent in municipal stations, while the corresponding proportions for 1907 were 76.6 per cent and 23.4 per cent, respectively. The following tabular statement shows the per cent distribution, by kind, of arc lamps, for commercial and municipal stations, for the years 1907 and 1902:

Commercial and municipal central electric stations—Per cent distribution of arc lamps, by kind: 1907 and 1902.

KIND.	TOTAL.		COMMERCIAL.		MUNICIPAL.	
	1907	1902	1907	1902	1907	1902
Total.....	100.0	100.0	100.0	100.0	100.0	100.0
Open.....	14.2	47.1	12.8	44.7	22.2	62.9
Inclosed.....	85.8	52.9	87.2	55.3	77.8	37.1

The change from open to inclosed arc lamps has been accompanied by a decided change in the kind of current used in operating them.

TABLE 48.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—ARC LAMPS, BY KIND OF CURRENT USED: 1907 AND 1902.

KIND.	TOTAL.		COMMERCIAL.		MUNICIPAL.		PER CENT OF INCREASE.		
	1907	1902	1907	1902	1907	1902	Total.	Commercial.	Municipal.
Total.....	1,555,713	385,608	372,773	334,903	82,940	50,705	44.1	41.2	63.3
Direct current.....	269,217	270,097	236,119	232,502	33,098	37,595	2.0	1.6	212.0
Alternating current.....	286,496	115,601	236,654	102,401	49,842	13,200	147.8	131.1	277.6

¹ Exclusive of 7,082 lamps used by central stations to light their own properties.

² Decrease.

Of the total number of arc lamps in 1902, seven-tenths were direct-current, but in 1907 the corresponding proportion was less than one-half. The increase of 170,015 arc lamps between 1902 and 1907 is due wholly to the gain in the alternating-current lamps, since there was an actual loss of 880 in the number of those operated by direct current. The change in the character of current used has taken place somewhat more rapidly in municipal than in commercial stations.

TABLE 49.—Commercial and municipal central electric stations—Per cent distribution of arc lamps, by kind of current used: 1907 and 1902.

KIND.	TOTAL.		COMMERCIAL.		MUNICIPAL.	
	1907	1902	1907	1902	1907	1902
Total.....	100.0	100.0	100.0	100.0	100.0	100.0
Direct current.....	48.4	70.0	49.9	69.4	39.9	74.0
Alternating current.....	51.6	30.0	50.1	30.6	60.1	26.0

Incandescent lamps.—The incandescent lamps have become an important adjunct to business, and in some of its uses may be rightfully classed as necessary to comfort, although in other cases its use is a luxury. Spectacular and beautiful effects are produced with incandescent lamps in outdoor and indoor illumination, while electric signs in motion effects and in colors, and window and store decorations of great brilliancy are now common in all large centers. These features have become so important in central-station work that a special department devoted to this branch of the service is considered necessary by many of the larger companies. The developments along the lines of incandescent lighting have been wonderful and the possibilities seem almost limitless.

Various kinds of lamps which in 1902 were in a semiexperimental stage have since become of demonstrated merit, while new ones are continually being invented. In fact, so numerous and so desirable were many of these lamps that at the census of 1907 it was

decided to add an inquiry calling for the number of such lamps, and, although it is probable that some lamps of these classes were erroneously reported as incandescent lamps, 162,338 lamps of the special varieties were reported separately by the various central

stations. In 1902 these types of lamps were probably included in the total number of incandescent lamps reported, and consequently their actual increase as given in Table 50 is less than it should be.

TABLE 50.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—INCANDESCENT LAMPS, BY CANDLE-POWER, AND OTHER VARIETIES OF LAMPS: 1907 AND 1902.

KIND.	TOTAL.		COMMERCIAL.		MUNICIPAL.		PER CENT OF INCREASE.		
	1907	1902	1907	1902	1907	1902	Total.	Commer- cial.	Municipal.
Incandescent lamps	¹ 41,445,997	18,194,044	37,303,549	16,616,593	4,052,448	1,577,451	127.8	125.0	156.9
Sixteen-candlepower	35,640,612	15,557,843	32,153,240	14,126,123	3,487,372	1,431,720	129.1	127.6	143.6
Thirty-two-candlepower	1,408,610	574,667	1,242,415	531,300	166,195	43,358	145.1	133.8	233.3
All other candlepower	4,396,775	2,061,534	3,907,894	1,959,161	398,881	102,373	113.3	104.1	289.6
Other varieties of lamps—Nernst, vacuum, vapor, etc	² 162,338	(³)	153,468	(³)	8,870	(³)	.....	.....	.....

¹ Exclusive of 266,242 lamps used by the central stations to light their own electric properties.
² Exclusive of 1,755 lamps used by the central stations to light their own electric properties.
³ Not reported separately.

The total number of incandescent lamps more than doubled between the censuses of 1902 and 1907, the increase being 23,251,953 lamps, or 127.8 per cent. Although this increase was mostly in 16-candlepower lamps, it also represents lamps varying from street lamps and those of 32 candlepower to the very small sign lamps. The increase is exclusive of 162,338 lamps of "other varieties," chiefly Nernst, and of 266,242 lamps used by the central stations to light their own properties.

The schedules used at both censuses were prepared in such a way that the number of incandescent lamps should be reported as of the following three classes: 16 candlepower, 32 candlepower, and all other candlepower. The wording of the inquiry was such as to ascertain the number of these lamps wired for service on December 31, or the last day of the period covered by the report, and not the actual number in use at different times during the year.

The continually decreasing practice of renting incandescent lamps for general commercial uses on a flat-rate basis and, as a consequence, the increasing use of meters to measure the amount of current consumed, render it no longer necessary in the majority of cases for the central stations to know the number of lamps wired for service or of machines in use, and although some companies reported the number of incandescent lamps, in accordance with the requirements of the schedule, many of the large companies claimed to have such limited knowledge of the number of these lamps wired for service that they were reluctant, and in some instances declined, to give even an estimate of the several varieties, but confined their answers to the inquiry to an estimate of the total number of incandescent lamps on a 16-candlepower basis. In view of these conditions, the results should be accepted only as an approximation of the total number of incandescent lamps wired for service and also of the

classes by candlepower. The actual number of arc lamps was reported by practically all companies.

In 1907, 3,136 companies reported lamps of 32 candlepower. There were 956 companies that reported none of this size, either because they actually had none of this size or because they prepared their schedule for the estimated number of incandescent lamps on a 16-candlepower basis. The remaining 504 stations that had incandescent lamps wired for service, so far as their equipment in that respect is concerned, reported 16's and "other varieties" or only "other varieties." The 956 central stations which reported no lamps of 32 candlepower reported a total of 13,407,883 lamps of 16 candlepower, or nearly one-third of the incandescent lamps reported by all stations. In this connection, however, it should not be forgotten that many of the companies which reported lamps of 32 candlepower stated that the number was estimated.

An attempt was made by correspondence on the subject with a number of central stations to obtain the proper ratio by which to reduce the total number of incandescent lamps shown in Table 50 to lamps of a uniform 16 candlepower. Applying the same ratio of reduction to the total number of lamps of all other varieties, it was found that the total lamps in question were equivalent to 40,656,220 incandescent lamps of 16 candlepower in 1907, and to 17,737,944 in 1902, an increase of 22,918,276, or 129.2 per cent. The difference of increase, as shown in Table 50 and as estimated on a basis of 16 candlepower, is smaller than might be expected, 333,677, or but little more than 1 per cent.

More than nine-tenths of the incandescent lamps were reported at each of the two censuses by the commercial stations, the actual proportions contributed by the municipal stations being 9.8 per cent in 1907 and 8.7 per cent in 1902.

CENTRAL ELECTRIC LIGHT AND POWER STATIONS.

The following statement shows the number of central stations, classified according to the kind of lamps wired for service, December 31, 1907:

Central electric stations—Number, by lamp equipment: 1907.

Total number of stations.....	4,714
With incandescent lamps.....	4,596
With lamps of 32 candlepower.....	3,136
With lamps of 16 candlepower only ¹	956
Without incandescent lamps.....	118
With arc lamps.....	3,700
Without arc lamps.....	1,014
Without either incandescent or arc lamps.....	68

¹ These 956 stations reported nearly one-third of the total number of incandescent lamps, and most of them reported only an estimate of the number of lamps on a 16-candlepower basis, because it was impracticable to answer the inquiries on the schedule in detail.

The increase in the use of electric light and the importance of the industry may perhaps be illustrated most satisfactorily by comparing the number of lamps with the population. Such a comparison is made in Table 51 for the 8 states that contained the largest number of incandescent lamps in 1907 and 1902.

The striking features of this table are the concentration in a comparatively few states of a large proportion of the electric lamps, and the great increase in the average number of lamps per 1,000 population. The 8 states here shown contained nearly two-thirds of the total number of both arc and incandescent lamps, the proportions for the two classes being practically the same, but represented a considerably smaller proportion of the total population, which fact merely illustrates the larger general use of the electric light in the thickly settled communities. Of the 8

states, Missouri shows the lowest and California the highest average number of lamps per 1,000 population. The population of Missouri is more than twice as great as that of California, but it is evident that the electrical development there has not reached the importance that it has in California. Both states contain a considerable proportion of rural population, which has been supplied with electricity more generally in California than in Missouri. In California a number of hydro-electric plants have been established throughout the state, primarily to supply current to large cities located at a distance, but these plants also supply intervening smaller places for which electricity might not otherwise be available. This condition contributes naturally toward the more extensive use of the electric light and an increase in the number of lamps. Although California holds a low comparative rank in population, it being the twenty-first state, it ranks fourth in the number of incandescent lamps and ninth in the number of arc lamps. In 1902 the state ranked fifth in the number of incandescent lamps and seventh in the number of arc lamps. Next to California, which has the smallest population of the 8 states shown in Table 51, New York, which is the most populous state of the Union, has the greatest average number of arc lamps per 1,000 inhabitants, and Massachusetts, the third largest average for arc lamps and the second largest for incandescent lamps.

TABLE 51.—CENTRAL ELECTRIC STATIONS—ARC AND INCANDESCENT LAMPS, FOR THE 8 STATES HAVING THE LARGEST NUMBERS OF INCANDESCENT LAMPS: 1907 AND 1902.

STATE.	ARC LAMPS.		INCANDESCENT LAMPS.		PER CENT DISTRIBUTION.				AVERAGE NUMBER OF LAMPS PER 1,000 POPULATION.			
	1907	1902	1907	1902	Arc lamps.		Incandescent lamps.		Arc lamps.		Incandescent lamps.	
					1907	1902	1907	1902	1907	1902	1907	1902
Total for United States.....	555,713	385,698	41,445,997	18,194,044	100.0	100.0	100.0	100.0	6.50	4.91	484.57	231.55
Total for selected states.....	358,114	252,316	25,817,953	11,817,849	64.4	65.4	62.3	65.0	9.89	7.55	712.99	353.46
New York.....	97,529	59,130	6,991,406	3,705,525	17.6	15.3	16.9	20.4	11.63	7.85	833.63	491.90
Pennsylvania.....	66,777	47,722	3,861,171	1,783,663	12.0	12.4	9.3	9.8	9.49	7.34	549.01	274.16
Illinois.....	55,309	38,215	3,582,178	1,507,665	10.0	9.9	8.6	8.6	10.02	7.61	649.16	312.31
California.....	19,691	15,764	3,067,383	1,006,875	3.5	4.1	7.4	5.5	11.75	10.25	1,831.04	654.73
Massachusetts.....	33,869	28,790	2,650,724	1,420,963	6.1	7.5	6.4	7.8	10.99	9.87	859.78	487.00
Ohio.....	43,849	31,839	2,254,467	934,213	7.9	8.3	5.4	5.1	9.75	7.49	501.30	219.69
Michigan.....	23,514	17,712	1,711,689	805,127	4.2	4.6	4.1	4.4	9.00	7.14	655.37	324.55
Missouri.....	17,576	13,144	1,098,935	593,798	3.2	3.4	4.1	3.3	5.16	4.12	498.82	186.32

The largest increases in the number of arc lamps are shown for New York, Pennsylvania, Illinois, Ohio, Indiana, New Jersey, Michigan, and Massachusetts. For the incandescent lamps large increases occur in so many states that it is difficult to select any as showing the greatest development, but in the following states the numbers for 1907 are at least three times as great as for 1902: Alabama, California, Idaho, Kansas, Kentucky, Maryland, Nebraska, Nevada, North Carolina, Oklahoma, Oregon, South Caro-

lina, and Washington. While these 13 states show the greatest proportional increases in the number of lamps, they do not represent the largest absolute increases, as their combined increase is exceeded by the gain in the total for the 2 states of New York and Pennsylvania.

The 162,338 lamps reported as "other varieties" in 1907 include those that were considered by certain of the establishments reporting as not properly belonging to the first group of incandescents. These

new types of lamps were not reported separately at the census of 1902, and, as already stated, it is probable that in 1907 lamps that properly should have been assigned to this group were included by many stations in the total for incandescent lamps. The total for 1907, however, included a number of the new varieties of lamps and, although thought to be far from complete, they are shown in the following statement:

Central electric stations—Lamps other than regular arc and incandescent, by kind: 1907.

KIND OF LAMP.	Number.
Total.....	162,338
Nernst.....	124,890
Meridian.....	5,214
Gem.....	3,343
Tantalum.....	2,467
Vapor.....	1,282
Tungsten.....	582
Vacuum.....	138
Not designated.....	24,413

The central stations were requested to name the lamps other than the regular arc and incandescent, but some reported a number without any designation, and the 24,413 "Not designated" no doubt include

some that might properly have been assigned to one or more of the other groups.

The use of electric lamps for advertising and decorative purposes has resulted in greatly increasing the varieties in use, and has also added to the difficulty of ascertaining the actual number wired for service on a given date. It was impossible, therefore, with a fair degree of accuracy to show separately the number of 16, 32, and other candlepower incandescent lamps, as was done at the census of 1902. However, the schedule used at the census of 1907 required that the number of 32-candlepower lamps wired for service be reported separately, and 3,136 stations reported 1,408,610, while the same stations reported a total of 27,248,337 incandescent lamps of all varieties. Using the ratio of these totals as a basis, the estimated number of 32-candlepower lamps wired for service at the close of 1907 was about 2,112,915.

Meters on consumption circuits.—It was impracticable to obtain statistics concerning the size of the meters in service, and therefore the extension of the service can be shown only by the number of meters. That the number has increased rapidly since 1902 is shown by Table 52.

TABLE 52.—CENTRAL ELECTRIC STATIONS—METERS ON CONSUMPTION CIRCUITS, FOR THE 8 STATES HAVING THE GREATEST NUMBERS OF METERS: 1907 AND 1902.

STATE.	TOTAL NUMBER.		Per cent of increase.	AVERAGE NUMBER PER STATION.		NUMBER OF CUSTOMERS FURNISHED CURRENT. ¹	AVERAGE NUMBER OF METERS PER CUSTOMER. ¹
	1907	1902		1907	1902		
Total for United States.....	1,683,917	582,689	189.0	357.2	161.0	1,946,979	0.9
Total for selected states.....	981,461	361,230	171.7	495.9	209.5	1,057,853	0.9
New York.....	217,462	73,789	194.7	692.6	288.2	201,701	1.1
Illinois.....	146,208	59,836	144.3	381.7	172.9	167,645	0.9
California.....	143,384	34,224	319.0	1,111.5	297.6	173,029	0.8
Pennsylvania.....	142,186	56,874	150.0	434.8	203.8	160,957	0.9
Ohio.....	92,964	31,508	195.0	341.8	135.2	100,071	0.9
Massachusetts.....	87,824	56,969	54.2	731.9	499.7	80,713	1.1
Michigan.....	78,950	29,272	169.7	337.4	145.6	87,500	0.9
Indiana.....	72,483	18,758	286.4	362.4	104.2	86,237	0.8

¹ Information not available for 1902.

The gain of 189 per cent in the number of meters no doubt indicates fairly well how complete the change has been from the flat-rate method of charging, so largely used at the earlier period of electric-station work, to the use of meters. There have been many and important changes in central-station practice during the short period between the two censuses, but none is more important, from the commercial point of view, than the general adoption of meter rates.

To obtain the total number of meters used for the sale of electricity it is necessary to add to the number shown in Table 52, the number on the consumers' circuits of electric-railway companies. There were 213,886 meters reported by such companies in 1907 and 56,601 in 1902, making the aggregates for the two

censuses 1,897,803 and 639,290, respectively, showing an increase of 1,258,513, or 196.9 per cent.

The 8 states represented in this table are those in which central stations have had the greatest development in the installment of meters, and contained 58.3 per cent of the total number of meters reported for all central stations in 1907 and 62 per cent of the total reported for 1902. The percentages of increase and the average number per customer indicate, however, that the practice has become very general.

The average number of meters per station is to some extent misleading because of differences due to peculiar conditions in certain states. In California, for instance, there is one company which generates electric current at a long distance from the main point of distribution

and supplies it to towns and cities in 22 counties, whereas a service of this sort in other states probably would be represented by a number of separate stations, so that the average number of meters per station would be considerably smaller. Probably the best indication of the growth in the use of meters may be had from the fact that of the 4,714 stations in 1907 only 629, or 13.3 per cent of the total, reported no meters, while in 1902, of a total of 3,620 stations, 901, or 24.9 per cent, reported none. The mechanical meter has now

come into such general use that the number of chemical and other varieties of meters were not reported separately in 1907 as they were in 1902.

Transformers in circuits for customers.—The increased use of alternating dynamos has necessarily been accompanied by an increase in the number of machines for lowering the pressure of the circuit. Step-down alternating-current transformers are in general use where alternating dynamos are employed.

TABLE 53.—CENTRAL ELECTRIC STATIONS—NUMBER AND KILOWATT CAPACITY OF TRANSFORMERS IN CIRCUITS FOR CUSTOMERS, FOR THE 8 STATES HAVING THE GREATEST KILOWATT CAPACITY: 1907 AND 1902.

STATE.	1907		1902		Per cent of increase in kilowatt capacity.	PER CENT OF TOTAL KILOWATT CAPACITY.		AVERAGE CAPACITY.	
	Number.	Kilowatt capacity.	Number.	Kilowatt capacity.		1907	1902	1907	1902
Total for United States.....	299,489	2,058,567	207,370	687,121	199.6	100.0	100.0	6.9	3.3
Total for selected states.....	169,674	1,326,338	113,046	425,715	211.6	64.4	62.0	7.8	3.8
New York.....	32,466	496,046	18,036	142,383	248.4	24.1	20.7	15.3	7.9
California.....	21,625	213,633	9,480	49,368	332.7	10.4	7.2	9.9	5.2
Pennsylvania.....	37,578	195,742	29,005	62,258	214.4	9.5	9.1	5.2	2.1
Illinois.....	20,331	99,007	15,040	46,515	113.0	4.8	6.8	4.9	3.1
Massachusetts.....	16,165	94,324	12,284	41,786	125.7	4.6	6.1	5.8	3.4
Ohio.....	18,991	91,064	11,925	34,600	163.2	4.4	5.0	4.8	2.9
Michigan.....	10,222	72,663	7,695	26,995	169.2	3.5	3.9	7.1	3.5
Indiana.....	12,266	63,799	9,581	21,810	192.5	3.1	3.2	5.2	2.3

The figures in this table represent only the transformers owned by the central stations. The number used by electric-railway companies was not reported at either census. As transformers are sometimes owned by the customers, the total shown in the table, 299,489, is somewhat less than the actual number used in connection with central-station service. The number of machines has, however, increased rapidly since 1902, but not so fast as their kilowatt capacity. This condition is due primarily to the fact that the old-style transformers in use in 1902 have been largely replaced by machines of much larger capacity, the average capacity per machine having more than doubled during the five years ending with 1907.

There were 1,126 stations in 1907 and 967 in 1902 that reported no transformers in use, the proportions being 23.9 and 26.7 per cent of the total number of stations at the respective censuses.

Stationary motors.—The schedule used at the census of 1902 called for the number of all kinds of stationary motors, including fan motors, while that for 1907 expressly excluded the latter class. No doubt many fan motors were reported at the census of 1902, but to what extent it is impossible to ascertain.

It was often extremely difficult to ascertain the horsepower capacity of the motors, the current to operate which was sometimes transmitted long distances to factories where the interest of the central station furnishing the electricity was confined to the amount of current consumed as measured by the

meters. It was necessary, therefore, to obtain estimates of the number and capacity of the motors. These estimates were included in the totals given in Table 54, which shows, for the United States and for the 8 states reporting the greatest horsepower capacity, the number and capacity of all stationary motors reported at the two censuses.

Next to lighting, stationary-motor service is the most important source of income for central electric stations, but the introduction of meters has complicated the difficulties attending the collection of statistics concerning the number and capacity of the motors. It is probable, therefore, that the totals in Table 54 are somewhat less than the actual number of motors wired at the end of the respective census years. Many large factories have the machinery operated entirely by electric power and some contain many motors for which statistics had to be obtained from the manufacturers, as the central stations were concerned only with the quantity of current sold.

As shown by Table 45, there were a number of stationary motors supplied with current by electric-railway companies which must be considered in arriving at the totals for this class of service. The figures in Table 54 indicate that the average size of the motors in the central stations has more than doubled since 1902, while the number increased by only 65.4 per cent, a difference in ratio of increase which is without doubt due to the fact that some large central stations reported the horsepower of the motors for which current was

supplied but expressed their inability to give even an estimate of the number of machines. This condition was pronounced in Pennsylvania, where the increase in the average capacity of the motors was excep-

tionally large—from 2.16 horsepower in 1902 to 12.17 horsepower in 1907. One large company in this state reported nearly one-third of its total stationary-motor power but was unable to state the number of motors.

TABLE 54.—CENTRAL ELECTRIC STATIONS—NUMBER AND HORSEPOWER CAPACITY OF STATIONARY MOTORS, FOR THE 8 STATES HAVING THE GREATEST HORSEPOWER CAPACITY: 1907 AND 1902.

STATE.	1907		1902		AVERAGE CAPACITY.		Per cent of increase in horsepower.	PER CENT OF TOTAL HORSEPOWER.	
	Number.	Horsepower.	Number.	Horsepower.	1907	1902		1907	1902
Total for United States.....	167,184	1,649,026	101,064	438,005	9.86	4.33	276.5	100.0	100.0
Total for selected states.....	106,321	1,107,687	67,037	309,655	10.42	4.62	257.7	67.2	70.7
New York.....	18,051	393,955	13,581	109,277	21.82	8.05	260.5	23.9	24.9
California.....	11,560	200,067	5,190	50,296	17.31	9.69	297.8	12.1	11.5
Illinois.....	21,675	137,661	11,838	35,923	6.35	3.03	283.2	8.3	8.2
Pennsylvania.....	10,063	122,461	14,144	30,560	12.17	2.16	300.7	7.4	7.0
Massachusetts.....	15,877	81,246	9,663	35,749	5.12	3.70	127.3	4.9	8.2
Ohio.....	13,083	64,941	5,704	21,956	4.96	3.85	195.8	3.9	5.0
Missouri.....	8,923	54,111	4,646	14,552	6.06	3.13	271.8	3.3	3.3
Michigan.....	7,089	53,245	2,271	11,337	7.51	4.99	369.7	3.2	2.6

The state of California, although having a comparatively small population, ranks second in the horsepower of its stationary-motor service, being outranked only by New York. This high rank is due to the scarcity of fuel in the state; the ease with which electric power may be transmitted and made available in sparsely settled sections; and its adaptability for use on dredgers and for many other purposes connected with mining and irrigation.

Modern central-station companies concern them-

selves little with the various uses made of the current sold. The quantity is measured, and as a rule the producers make no inquiry as to its use. Electricity is used for a multitude of miscellaneous purposes which consume, however, but a small proportion of the amount generated, much the larger portion being used for light and power. Table 55 shows the number of stations which sold current for the various purposes during the years 1907 and 1902.

TABLE 55.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—NUMBER OF STATIONS, BY CHARACTER OF SERVICE: 1907 AND 1902.

CHARACTER OF SERVICE.	TOTAL.		COMMERCIAL.		MUNICIPAL.		PER CENT OF INCREASE.		
	1907	1902	1907	1902	1907	1902	Total.	Com-	Muni-
								mercial.	cipal.
Arc lighting:									
Commercial.....	2,381	2,020	1,840	1,667	541	353	17.9	10.4	53.3
Public.....	3,298	2,522	2,206	1,810	1,092	712	30.8	21.9	53.4
Incandescent lighting:									
Commercial.....	4,538	3,484	3,385	2,752	1,153	732	30.3	23.0	57.5
Public.....	3,345	2,491	2,327	1,889	1,018	602	34.3	23.2	69.1
Motor power:									
Stationary.....	2,009	1,093	1,659	975	350	118	83.8	70.2	196.6
Electric-railway.....	217	159	211	157	6	2	36.5	34.4	200.0
All other electric service.....	999	161	831	152	168	9	520.5	446.7	1,766.7

There were only 68 central stations in 1907 which reported that the entire amount of electricity generated during the year was sold for motor service, disposed of in bulk to other electric or railway companies, or sold for some purpose other than lighting; all the other stations reported the sale of current for lighting. That electric lighting is the chief business of the central sta-

tions is shown also by the fact that of the total income, almost three-fourths was from lighting and about one-sixth from stationary-motor service.

Average size of station.—The number of lamps, meters, transformers, and motors is an indication of the size of the central station, and averages based on the numbers of these machines are given in Table 56.

CENTRAL ELECTRIC LIGHT AND POWER STATIONS.

TABLE 56.—Commercial and municipal central electric stations—
Average number of lamps, meters, transformers, and motors per
station and average capacity per machine: 1907 and 1902.

	TOTAL.		COMMERCIAL.		MUNICIPAL.	
	1907	1902	1907	1902	1907	1902
Arc lamps:						
Average number per station.....	118	107	137	119	66	62
Incandescent lamps:						
Average number per station.....	8,792	5,026	10,801	5,924	3,237	1,936
Meters on consumption circuits:						
Average number per station.....	357	161	424	188	172	70
Transformers in circuits for customers:						
Average number per station.....	64	57	74	64	35	34
Kilowatt capacity per machine.....	7	3	7	3	4	3
Kilowatt capacity per station.....	437	190	548	218	129	92
Stationary motors:						
Average number per station.....	35	28	47	35	4	2
Horsepower per motor.....	10	4	10	4	7	2
Horsepower per station.....	350	121	467	155	25	4

Although there are conflicting elements entering into the details from which these totals are obtained, the figures are of sufficient accuracy to establish the fact that the averages for 1907 show great increases over the averages for 1902.

Line construction.—The report on central electric stations for 1902 presents statistics for 125,144.14 miles of mains and feeders contained in overhead, underground, and submarine construction. Comparatively few companies, however, had definite knowledge of the miles of wire strung, and it was exceedingly difficult to obtain satisfactory answers to the census inquiries on the subject. In 1907, therefore, the inquiry on the subject was confined to the single question as to the number of miles of street occupied by underground conduits for mains and feeders, for which a total of 2,509.15 miles was reported. Of this total, 2,268.34 miles were reported by commercial stations and 240.81 miles by municipal stations.