CENTRAL ELECTRIC LIGHT AND POWER STATIONS

30947—05——1

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CHAPTER I.

SCOPE AND METHOD OF INVESTIGATION.

Central electric light and power stations.—This report presents the statistics for all central electric light and power stations in operation in the United States during any portion of the year ending June 30, 1902. Central electric stations are plants owned or operated by individuals, companies, corporations, or municipalities and furnishing current for public or commercial uses. Some of the central stations generate current for sale at certain rates to the general public, the current being available to all within reach of the distributing mains; others, owned by municipalities, generate current only for municipal uses.

The commercial uses comprise the heating and lighting of private dwellings, hotels, business houses, and office buildings; the furnishing of power for the propulsion of electric motors attached to elevators, ventilating fans, etc., as well as those in factories and in other industrial establishments; and the supplying of current to railways for the operation of cars. The public uses relate more particularly to the lighting of streets, parks, docks, and municipal buildings.

In the collection and compilation of these statistics great care was taken to restrict the figures to central stations proper.

The term "station," while used throughout this report as a synonym for plant, is not strictly an equivalent, but is thus employed for purposes of convenience. In reality the station may comprise two or three, or even more, plants in a single city, and the tendency toward financial and physical consolidation makes it difficult to obtain figures that fairly represent the real growth in number. Some of the larger cities that reported only one or two stations had, as a matter of fact, several, all of which were capable of generating current, although but one or two were used as main sources of supply. For instance, at the time of this report the Edison Electric Company, of Los Angeles, Cal., although its plans were not fully consummated, was generating current in three mountain water plants and four steam plants in different localities with coal, oil, and natural gas as possible fuel. These seven plants, some of them miles apart, were connected by transmission lines, and all were included in one report, and therefore in these statistics they have been enumerated as one station.

Other sources of electric current.—Current is also generated in isolated plants, and some of these plants might be considered within the category of central stations, since, in addition to generating current for their own consumption, they have a surplusage that is disposed of to people in the vicinity. Such business, however, is done without a charter or franchise and requires virtually no ordinance; moreover, the wires rarely cross any thoroughfare, the supply of current not being available to the public generally. Such plants have been excluded from the scope of the present inquiry, although incidental reference will from time to time be made to the work of these plants. In fact, no statistics of isolated plants are included in this report, which, to that extent, therefore, falls short of embracing the entire electric light and power industry of the United States. Many of these isolated plants are of a very extensive and important character, being supplied with the most improved apparatus and giving facilities equal to those furnished to populous communities. It is estimated that there are 50,000 of these plants, and that they consume at least half the product in some lines of electric apparatus. A great many of these isolated plants, moreover, have connections with the mains of electric light stations, so that they can avail themselves of the supply of central station current should the necessity to do so arise.

Another source of supply of current for electric light and power purposes is that to be found in electric railway plants, the statistics for which are presented in the Report on Street and Electric Railways. Reference will be made to the figures for such plants, although they are not included in the present report. At the time of the collection of the statistics presented herewith, less than 4 per cent of the plants generating and distributing current for light and power purposes were operated in connection with electric railways.

There is a steady tendency toward the consolidation of electric lighting and other industrial enterprises, especially gas plants, waterworks, ice plants, and electric railways, where the systems happen to be of such size that economy can be effected by putting them under one management. In the case of such composite stations the statistics presented in this report relate only to the generation of electric current by them; if book accounts were not available for exact information concerning the operation of the electric station as distinct from other business, careful estimates were prepared for the answer to each of the inquiries.

Recent origin of the industry.—While electric arc lamps were known experimentally during the early half of the last century, they were not used commercially until 1876, and then only to a limited extent. The first central electric light station furnishing current to such lamps was not installed until 1879. The incandescent lamp industry may be said to have been virtually nonexistent in 1880, as the lamps were not introduced commercially until about that time, and the first central station supplying current to such lamps did not go into operation until 1882; although it is recorded that some incandescent lamps had already been operated tentatively on arc lighting circuits.

It is indeed an interesting and extraordinary feature of electric lighting development that the two branches of the industry, arc lighting and incandescent lighting, should have grown up and developed for several years separately and quite independently. Indeed, the earlier years of the industry were marked by a hostility between the two kinds of plants which was sometimes even ferocious in its nature, but which was soon found to be due to intense commercial rivalry rather than to any inherent incompatibility of a technical description. The period up to 1890, while marked by a vigorous and rapid extension of electric lighting, still witnessed a great deal of experimental and unsuccessful work and, as a result of the fact that separate apparatus was used for different classes of current generation and service, the expenses of operation were abnormally high, even in stations in which the arc and incandescent systems had been consolidated. In fact it may be questioned whether, had the two classes of lighting remained independent and rival enterprises, the industry as a whole could have made the remarkable advances that have been apparent since the methods were worked out and perfected which enable one source of current supply to feed from the same dynamos apparatus of the most varied and heterogeneous nature—arc lamps, incandescent lamps, stationary motors, railway motors, electric fans, electric heaters, plating baths, etc.

Effect of recent discoveries.—In view of the recent discoveries in the electrical field and the revolutionary improvements made in many classes of apparatus, it is obvious that a new industry is being dealt with, where statistics can not be quoted quite so confidently as those of an industry running back through centuries and subject to a slow evolution, the processes of which had been watched by generations of keen observers. Nevertheless it seems fair to assert that in electric light and power development the growth has been at a rate of unusual acceleration, so that even in so short a period as a quarter of a century the foundations of a stable and permanent industry have been deeply laid. Even if the period prior to 1890 was of a formative character, the inventions and improvements of the last ten years have been such as to lead some critics to suggest that in certain lines the limits of possible perfection have already been reached. The figures of the next census, therefore, while they may still exhibit a high percentage of increase and will certainly include the statistics for many novel appliances not now recorded as within the scope of the central station equipment, may possibly be found in many respects to exhibit an orderly sequence and a definiteness of function such as is always expected in a well-established industry.

It is to be observed in this connection that whereas in 1880 and in 1890 the area of central station current supply was strictly limited so that each station, like a gas plant, was able to supply only a narrow region at comparatively low pressures, at the present time, in many sections, the rural as well as the urban portions of the country are being covered by a network of electric circuits, and a few stations embrace in their operation whole counties and even larger districts. This work of electric transmission is apparently capable of indefinite extension, but the inference is justified that the broad basis and ultimate lines of operation have now been indicated in practice, subject to later filling in and solidification, very much in the same manner as the trunk railroads have been laid out and built up, to which other systems and even the wonderful network of rural trolley lines serve but as auxiliaries and feeders.

Period covered.—The statistics, as a rule, cover the twelve months ending June 30, 1902, but in some instances the reports are for the calendar year 1901 or 1902, and in a considerable number of cases for other periods of twelve months. Stations in operation during any part of the year are included. There were 141 private stations and 38 municipal stations that reported for a period of less than a year. Nearly all of these stations were just beginning operations, although in a few instances stations were in operation during the entire

year, but on account of changes in ownership, reports could be secured for a part of the year only. Since a very large proportion of these stations are located in small towns and villages, where the plants are not extensive, this inclusion does not materially affect the totals. Stations that were under construction and those that had not begun operations are not included.

Special agents of the Bureau visited the officials of every station to secure the returns. In almost all cases full and complete answers to the inquiries were given. However, in some instances the agents, in conjunction with the officials, found it necessary to make estimates where accurate reports had not been kept.

In the appendix will be found a copy of the schedule used in this investigation and also a copy of the instructions to special agents securing the returns.

Basis of classification of stations.—The conditions under which the different stations are operated and the miscellaneous character of the service which they are called upon to furnish are so varied that in presenting the statistics it has been deemed advisable to group together, so far as possible, those stations which operate under similar conditions, in order that the results may be studied and analyzed. Therefore, the stations have been divided into those operated by individuals and corporations and those operated under municipal control, and subdivided into those doing a purely electric business and those operated in connection with other industries. For convenience, the latter are designated composite stations.

Further subdivisions have been made, one being based upon the population of the place in which the station is located and the other upon the horsepower capacity of the generating apparatus of the station.

Classification according to population.—Central electric stations are divided according to population into the following groups:

1. Stations in places having a population of less than 5,000.
2. Stations in places having a population of 5,000 but less than 25,000.
3. Stations in places having a population of 25,000 but less than 100,000.
4. Stations in places having a population of 100,000 but less than 500,000.
5. Stations in places having a population of 500,000 and over.

In a majority of cases the service furnished by stations is limited practically to the territory of the municipalities in which they are found, yet many stations supply current for light and power to a number of cities and towns besides those in which they are located. It is believed that in general the size of the place has a great influence on the size of the plant, the rate of wages paid, and the price received for the current.

Classification according to dynamo capacity.—The classification, based on the horsepower capacity of the generating apparatus, is as follows:

1. Stations having dynamos with a horsepower capacity of less than 200.
2. Stations having dynamos with a horsepower capacity of 200 but less than 500.
3. Stations having dynamos with a horsepower capacity of 500 but less than 1,000.
4. Stations having dynamos with a horsepower capacity of 1,000 but less than 2,000.
5. Stations having dynamos with a horsepower capacity of 2,000 but less than 5,000.
6. Stations having dynamos with a horsepower capacity of 5,000 and over.

While many of the stations have generating equipment in excess of their present needs, it is believed that this classification furnishes data as to the economy of the operation of plants of different sizes, inasmuch as on the size of the plant depend largely the cost of construction and equipment, the number of wage-earners employed, the amount and cost of supplies, materials, and fuel needed, and the "load" under which the machinery is operated.

CHAPTER II.

SUMMARY AND ANALYSIS OF RESULTS.

General totals.—The magnitude of the industry in 1902 is shown by the statistics in Table 66, which presents the leading items by states. The totals for all stations and for private and municipal stations, respectively, are summarized in the following table:

TABLE 1.—*Central electric stations: 1902.*

	Total.	Private stations.	Municipal stations.
Number of stations	3,620	2,805	815
Cost of construction and equipment	$504,740,352	$482,719,879	$22,020,473
Gross income	$85,700,605	$78,735,500	[1] $6,965,105
Income from sale of current	$84,186,605	$77,349,749	[1] $6,836,856
Income from all other sources	$1,514,000	$1,385,751	$128,249
Total expenses	$68,081,375	$62,835,388	$5,245,987
Salaried officials and clerks:			
Number	6,996	6,046	950
Salaries	$5,663,580	$5,206,199	$457,381
Wage-earners:			
Average number	23,330	20,863	2,467
Wages	$14,983,112	$13,560,771	$1,422,341
Power plant equipment:[2]			
Steam engines—			
Number	5,930	4,870	1,060
Horsepower	1,379,941	1,232,923	147,018
Water wheels—			
Number	1,390	1,308	82
Horsepower	438,472	427,254	11,218
Generating plant equipment:			
Dynamos—			
Direct current, constant voltage—			
Number	3,823	3,405	418
Horsepower	442,446	418,913	23,533
Direct current, constant amperage—			
Number	3,539	2,957	582
Horsepower	195,531	157,768	37,763
Alternating and polyphase current—			
Number	5,122	4,300	822
Horsepower	987,003	896,315	90,688
Output of stations in kilowatt hours, total for year	2,507,051,115	2,311,146,676	195,904,439
Total number of arc lamps	385,698	334,903	50,795
Total number of incandescent lamps	18,194,044	16,616,593	1,577,451

[1] Includes estimated income from public lighting.
[2] In addition there were gas engines and auxiliary steam engines with a capacity of 26,635 horsepower.

The statistics are summarized in Table 1 so as to show the totals for the entire industry and of the plants controlled by private and municipal ownership, respectively. The details are given in subsequent tables. The kilowatt hour, for which totals are given in the above table, is the universal basis of computation with regard to the output and payment for current. Although the flat rate is still largely used, it is based upon an arbitrary assumption of a given amount of current being supplied in a specified time.

Isolated and railway plants.—In addition to these grand totals of the industry, other figures should be taken into consideration in order to arrive at the real extent of the central station supply systems of the country. As already noted, a few isolated plants, out of the 50,000 estimated to be in operation in the United States, do some actual business in the way of selling current and giving general service, but no canvass was made to elicit the details; and, moreover, the figures for this part of the industry would be insignificant in comparison with the totals. During the year 1902, there were 253 electric railway companies that reported income received from the sale of current for light and power, and the companies selling current for such purposes are increasing in number. Of the 253 companies, 118 reported the number of lamps in use and the amount of income from the sale of current. The statistics for these companies are shown in Tables 97 and 98. If the statistics from this group be added to those already cited in Table 1, the number of stations would be increased to 3,738; the total income from the sale of current to $90,458,420; the number of arc lamps to 419,561; and the number of incandescent lamps to 19,636,729. For detailed statistics of the power and generating equipment of these plants, reference should be made to the Report on Street and Electric Railways. The subject will, however, be taken up incidentally under various headings in the present report.

Comparison of the statistics of private and municipal stations.—According to Table 1, private stations form by far the largest portion of the industry, constituting 77.5 per cent of the total number of stations in operation during 1902. Their income from sale of current formed 91.9 per cent of gross income, the expenses of operation 92.3 per cent of the total, while they gave employment to 89.4 per cent of the total number of wage-earners engaged in the industry and paid 90.5 per cent of the total amount of annual wages. The primary power plant equipment of these stations formed 91.3 per cent of the total horsepower of all stations, while their generating equipment formed 90.6 per cent of the total horsepower of all dynamos. The kilowatt hour output of private stations formed 92.2 per cent of the total, and the arc lamps in such stations formed 86.8 per cent of the total number wired for operation.

The comparison of the income of the two classes of stations is not a fair indication of their earning capacity, because of the gross income reported for municipal stations. Of this gross income, $6,836,856 resulted from the sale of current and included income from public service which was necessarily largely, if not wholly, a matter of estimation, as a municipal plant can scarcely be said to charge itself a rate for the work done. The estimated income is, therefore, the amount that presumably would

have been paid for the service had it been supplied by a private enterprise or, in other words, the amount that would have been paid by a private customer taking such service from the municipal plant. In cases where it was necessary to determine this item of income from public service, the effort was made to bring such figures into harmonious relation with those applying elsewhere in the state or section, so as to make them reasonable and consistent with prevalent rates in communities of the same character.

The municipal stations employed 2,467 wage-earners, who were paid wages amounting to $1,422,341, and 950 salaried officials and clerks, who were paid $457,381. Here, again, it should be understood that in many cases the same officials or the same workmen were charged with other duties, and when the amounts chargeable to electric lighting were not separately and specifically stated, they had to be determined by careful analysis.

The cost of construction and equipment of the municipal stations was only 4.4 per cent; their income from sale of current, 8.1 per cent; their expenses, 7.7 per cent; and the horsepower capacity of their power and generating plants, 8.7 and 9.4 per cent, respectively. The output of such stations was 7.8 per cent of the total kilowatt hours produced by all the stations, while their arc lamps were 13.2 per cent and their incandescent lamps, 8.7 per cent of all the lamps reported for the country.

In addition to controlling practically the entire industry, the average private station is much larger than the average municipal station. Considering the total of 2,805 private stations, it appears that the average total expense per year per station was $22,401, as compared with $6,437 for municipal stations. The private stations gave employment on the average to 7.4 wage-earners, while the municipal stations gave employment to 3. The average private stations reported 823,938 kilowatt hours per year, as compared with 240,373 for the municipal stations.

TABLE 2.—*Number of central electric stations beginning operations during each year.*

YEAR.	Total.	Private stations.	Municipal stations.
Total	3,620	2,805	815
1902 (January 1 to June 1)	146	106	40
1901	250	185	65
1900	213	152	61
1899	237	178	59
1898	277	195	82
1897	228	170	58
1896	193	129	64
1895	239	166	73
1894	191	144	47
1893	192	161	31
1892	247	190	57
1891	198	157	41
1890	227	198	29
1889	208	168	40
1888	160	142	18
1887	147	127	20
1886	100	86	14
1885	55	49	6
1884	47	43	4
1883	27	25	2
1882	30	27	3
1881	8	7	1

By means of Table 2 the beginnings of the industry are carried back to the first years of central station development on a commercial basis. The 3,620 stations comprised 2,805 that were private or corporate enterprises and 815 that were carried on by municipalities. The table does not include any stations that had gone out of existence prior to 1902, or those merged with other plants, and to that extent falls short of indicating the full number installed each year. Inquiry as to the exact number of those that had gone out of existence yielded very indefinite results, but it does not appear that the number is very large, much the greater number, as a matter of fact, having been merged in later enterprises.

It will be seen from the table that from 8 stations beginning operation in 1881 the number rose to 100 in 1886, to 208 in 1889, and to 247 in 1892—a year that will be remembered as marking the crest of a long period of prosperity. During the following years of depression the number fell again, but in 1895, which was a time of financial stringency and consequently of small desire to engage in new enterprises, the number again rose to the remarkable point of 239, while in 1898 it reached 277, or more than the number beginning operations during the whole period from 1881 to 1886, inclusive. The number for the year 1901 was 250, and for only five months of the year 1902 there were 146 new stations, from which fact it would appear that in all probability the rate of increase not only had been sustained, but also had reached a higher point than at any other time during the twenty-two years. Taking the period from 1881 to 1901, inclusive, it will be seen that an average of 165 private and municipal stations have begun operations each year.

The spread of the agitation for municipal ownership of public service enterprises is illustrated in a somewhat striking manner in Table 2. Of the 815 municipal stations enumerated, only 68 had been put in up to 1889. In that year 40 were introduced and in 1895 the number of new stations reached 73, increasing in 1898 to 82. The returns for 1902 indicate that the ratio was fully maintained in the census year.

The conditions during late years, moreover, are affected by the fact that the larger centers of population were furnished with central stations during the earlier years of the industry, and, consequently, the new plants are more likely to represent individual enterprises in smaller towns and cities that had not been previously supplied but had, in fact, just reached the stage at which it was profitable or desirable to create a private or municipal investment in them for electric lighting.

Ownership of stations.—In further consideration of the total number of stations, attention is called to the fact that 2,805, or 77.5 per cent, were operated under private or corporate ownership, while 815, or 22.5 per cent, were operated under municipal control. In 1902, 13 stations that had been installed under municipal con-

trol were being operated under private ownership. Of the 815 municipal stations, 77 began operations under private or partnership management and 93 under corporate management. Table 69 shows further division of the statistics for stations under private ownership and reveals the fact that 964 stations, or 34.4 per cent, were installed by individuals or firms and 1,828, or 65.2 per cent, by corporations. As might be expected, however, since from many points of view the nature of the business requires corporate management, the number of stations operated by individuals or private firms has shown a tendency to decline, and at the time of the enumeration in 1902 it had fallen to 756, or 27 per cent, while the number controlled by corporations had increased to 2,049, or 73 per cent.

Relation of leading items to geographic divisions.—In the following table the number of all stations and of private and municipal stations, respectively, together with various other items, are shown for the different geographic divisions:

TABLE 3.—RELATION OF LEADING ITEMS TO POPULATION—CENTRAL ELECTRIC LIGHT AND POWER STATIONS, BY GEOGRAPHIC DIVISIONS: 1902.

DIVISION.	Population.	NUMBER OF STATIONS.			COST OF CONSTRUCTION AND EQUIPMENT.		HORSEPOWER OF POWER PLANT.		HORSEPOWER OF GENERATING PLANT.		OUTPUT OF STATION IN KILOWATT HOURS.		ARC LAMPS.		INCANDESCENT LAMPS.	
		Total.	Private.	Municipal.	Amount.	Per capita.	Amount.	Per capita.	Amount.	Per capita.	Amount.	Per capita.	Number.	Per capita.	Number.	Per capita.
United States..	75,994,575	3,620	2,805	815	$504,740,352	$6.64	1,845,048	0.0243	1,624,980	0.0214	2,507,051,115	32.99	385,698	0.0051	18,194,044	0.2394
North Atlantic	21,046,695	913	810	103	266,548,738	12.66	814,728	0.0387	693,765	0.0330	1,269,331,001	60.31	169,554	0.0081	8,561,205	0.4068
South Atlantic	10,443,480	251	176	75	19,462,480	1.86	92,611	0.0089	83,515	0.0080	102,990,575	9.86	17,183	0.0016	611,001	0.0585
North Central	26,333,004	1,706	1,178	528	127,495,351	4.84	539,669	0.0205	503,368	0.0191	645,062,113	24.50	145,529	0.0055	6,176,919	0.2346
South Central	14,080,047	404	323	81	22,328,727	1.59	117,192	0.0083	110,266	0.0078	153,905,350	10.93	23,320	0.0017	1,022,298	0.0726
Western	4,091,349	346	318	28	68,905,056	16.84	280,818	0.0686	234,066	0.0572	335,762,076	82.07	30,112	0.0074	1,822,621	0.4455

The greatest number of central stations was found in the North Central states. According to Table 65 this division contained in 1890, 43.1 per cent of all the stations in the United States, a proportion which in 1902 had increased to 47.1 per cent. The greatest percentage of increase in the number of stations is found in the South Central states. Up to 1890 only 79 stations had been installed in that division. In 1902 this number had increased to 404, a gain of 411.4 per cent during the period. This remarkable gain is seen to be coincident with the greater industrial activity in the South.

While the number of stations in the North Central region is almost equal to the total for all the other sections of the country, it is only in this respect and in the number of inhabitants that this region preponderates to any extent in the comparison. In the North Atlantic states the 913 stations represented a cost of construction and equipment of $266,548,738, or slightly more than half of the total for the whole country, and they served more than one-quarter of the whole population. The output of these stations was almost exactly one-half of the total for the country, namely, 1,269,331,001 kilowatt hours out of a total of 2,507,051,115. While the average per capita consumption for the year was barely 33 kilowatt hours for the whole country, it was 60.3 kilowatt hours for the North Atlantic states. Of the total horsepower of the power plants, 814,728 horsepower, or 44.2 per cent, was located in the North Atlantic division. In this division the proportion of the dynamo generating power was almost the same, being 42.7 per cent, or 693,765 horsepower, out of 1,624,980 horsepower.

The two main items of central station work are arc lighting and incandescent lighting. Of the 385,698 arc lamps in the United States in 1902, 169,554 were to be found in the North Atlantic division, but the North Central division compared closely with this, having 145,529, so that these two divisions reported 315,083, or 81.7 per cent of the total. Moreover, these two divisions contained almost as high a percentage of incandescent lamps, for out of a total of 18,194,044 such lamps, 8,561,205 were reported in the North Atlantic division and 6,176,919 in the North Central division.

The South Atlantic division, although not the smallest as to population served, contained the smallest number of stations, namely, 251, with a cost of construction and equipment of $19,462,480, while the stations in the South Central division numbered 404 and cost $22,328,727. It will be noted that as compared with these, the Western division, with a population of only 4,091,349, had 346 stations with a cost of $68,905,056. These figures speak eloquently not only of the greater development of electric lighting in the Far West but also of the higher cost per plant and of the fuller service to the community. While in the South Atlantic and South Central divisions the per capita horsepower of power plants was only 0.0089 and 0.0083, respectively, it rose in the Western division to 0.0686, or nearly twice as much as the average of 0.0387 in the North Atlantic division. The consumption of current in the Western division was 82 kilowatt hours per capita, or about eight times as great as the consumption in either the South Atlantic or the South Central division, and more than three times as great as that in the North Central division. The explanation of the large consumption of current in the Western division is found in the figures of the arc and

incandescent lamps installed there. There were 17,183 arc lamps in the South Atlantic states, 23,320 in the South Central, and 30,112 in the Western. In like manner, while there were 611,001 incandescent lamps in the South Atlantic division, and 1,022,298 in the South Central, there were in the Western 1,822,621, or more than the total for the two southern divisions. While the per capita of the arc lamps in the Western division was slightly less than that of the North Atlantic states, namely, 0.0074, as compared with 0.0081, the conditions were reversed with regard to incandescent lamps, the per capita for the Western division being 0.4455, as compared with 0.4068 for the North Atlantic division. The per capita for incandescent lamps in the Western division was nearly twice as great as that for the North Central division, which showed 0.2346. With regard to the number of arc lamps, however, the difference between these two divisions was not so great, the per capita being 0.0055 for the North Central division, as compared with 0.0074 for the Western division.

It does not follow, however, that these figures are altogether an exhibition or reflection of the relative enterprise and development of the various sections. The presence of large industries or of large centers of population has its effect in various ways. Interesting light upon the attitude of the people in different sections toward electric applications is furnished by the earnings in the states and cities, reported and discussed elsewhere. Because of the newness of many of the communities in the Western division, the central station has often been the first public service plant of any kind installed, so that the public have had to depend upon it almost exclusively for lighting, and sometimes for power, while the management has not had to meet the competition of gas plants, which are naturally more numerous in the older settled portions of the country.

The average cost of construction and equipment for the 3,620 stations enumerated was $139,431, with which it is interesting to compare the average for the gas companies, namely, $646,523, although the latter is apparently rather on the basis of capitalization than investment. The average cost of construction and equipment for stations in the North Atlantic division was $291,948. Following this in magnitude came the western stations with $199,148, the South Atlantic with $77,540, the North Central with $74,733, and the South Central with $55,269.

When it is considered that many of the western plants are of the latest construction and would therefore have the benefit of all the economies introduced, the high ratio of cost of construction and equipment seems in need of explanation. One plausible reason for it is that a number of western plants included long distance transmission circuits, which would tend very much to increase the construction cost. Another is that many stations are remote from the mechanical centers at which the apparatus is produced, and the freight charges are therefore heavy. A third reason is probably to be found in the fact that while the plants of the older sections of the country are not equipped greatly in advance of the prospective growth, the western plants have been boldly equipped with an eye to the future and on a scale exemplifying the hopefulness of the investor with regard to the rapid development of that region. It might be urged, also, that the scale of prices for construction and equipment in the Far West is on the average higher than elsewhere in the country, but this argument might be equally true of many sections of the South. Although this statement does not apply to labor, it is a fact worthy of note that the work involved in the construction and equipment of a central station is of a high technical character wherever performed. A large expenditure, however, is justified by the liberal patronage bestowed on the western stations, the kilowatt hour consumption of current being, as already noted, much larger in that division than in any other section.

Distribution of stations, by states.—From Table 65 it will be seen that the largest number of stations was in Illinois, followed by Pennsylvania, New York, Ohio, Michigan, Indiana, Iowa, and Wisconsin in the order named. No other state reached the 150 mark. The New England states were well supplied with stations. Massachusetts reported the largest number; then came Maine, Vermont, New Hampshire, and Connecticut. Among the Southern states Texas led, with Kentucky, Tennessee, and Georgia following. Of the Western states, California reported the largest number of stations, Colorado, Washington, Oregon, and Montana being next in order.

Distribution of stations according to population of places in which located.—Of the 1,892 places reported at the Twelfth Census as having a population of 2,500 and over, 1,511 had one or more central electric lighting stations that were operated either as independent enterprises or in connection with electric railways. Of the places with a smaller population, 1,960 had similar stations. As elsewhere noted, a number of large central electric light or power stations furnished current to surrounding cities, towns, and villages, either directly or through the intermediary of substations, and it would be very difficult to include all the population of the country to which central station current was available, a mere enumeration of the places where the stations are installed by no means indicating alike the topographic location of the plants and the territorial distribution of the current. There are, in fact, a number of companies supplying areas of many square miles in which are located scores of cities, towns, incorporated villages, and mere hamlets, all enjoying the benefits of electricity and constituting a source of income for the enterprise. The extreme limit of such work at the time of this report was marked by the long distance power transmission on the Pacific coast, where current from the Sierras was actually delivered for general consumption in San Francisco and Sausalito, and was also distributed from the

same plants over lines which ramify into half the counties of the state of California.

The whole aspect of central station current supply in its relation to population has in reality been utterly changed by the development of polyphase power transmission, which will be treated more fully in a later chapter of this report. Utilizing chiefly remote waterpowers, but depending in many cases upon coal, hundreds of power transmission plants have been put in with the sole object of furnishing current for both light and power over large areas. Thus, in numerous instances, the production of current has been minimized in the city of consumption itself, the supply coming from points scores of miles away and being available, therefore, not only in the heart of the business community it is primarily intended to serve, but also in numerous little communities intermediate, which but for this technical advance would have remained without the convenience of electricity, or without it, might not have existed. There are at least a thousand such transmission plants, and a cursory examination of the statistics shows that the transmission lines were frequently 15 or 20 miles long, in many cases 40 or 50 miles, not seldom 60 or 90 miles, and sometimes even 150 or 200 miles.

These transmission enterprises are peculiarly typical of the far Western states, but are by no means concentrated there, being scattered all over the Union, particularly in mountainous regions where water supply, even if not abundant, can be secured with a good head, the height of the fall thus compensating for the smallness of volume.

The classification of central stations in groups of cities of different population brings out a number of interesting facts as to the degree of dependency of the public upon private enterprise and upon municipal control in this field of industrial endeavor. In Table 4 the number and percentages of private and municipal stations, respectively, are shown for cities grouped according to population.

TABLE 4.—*Number of private and municipal stations, grouped in places classified by size, and percentage each group is of total: 1902.*

POPULATION OF PLACES IN WHICH LOCATED.	TOTAL.		PRIVATE STATIONS.		MUNICIPAL STATIONS.	
	Number.	Per cent.	Number.	Per cent.	Number.	Per cent.
Total	3,620	100.0	2,805	100.0	815	100.0
Under 5,000	2,714	75.0	2,043	72.8	671	82.3
5,000 but under 25,000	675	18.7	554	19.8	121	14.9
25,000 but under 100,000	128	3.5	115	4.1	13	1.6
100,000 but under 500,000	73	2.0	67	2.4	6	0.7
500,000 and over	30	0.8	26	0.9	4	0.5

It will be seen that 2,714, or three-fourths of all the central stations reporting in 1902, were located in places of less than 5,000 inhabitants; of the private stations 72.8 per cent were in this group, while not less than 82.3 per cent of the municipal plants were to be found in it. In both cases the percentage is high and exemplifies the wide diffusion and enjoyment of the facilities afforded by such services. In this respect the small towns of the North Central states appear to have had exceptional advantages, as of the stations in Illinois and Iowa 428, or 83.1 per cent, were in the small towns, while in Ohio and Indiana 284, or 68.8 per cent, were so located.

Distribution of stations according to dynamo capacity.—Table 5 segregates the central electric stations according to the horsepower capacity of the dynamos and assists in determining the relative size of the municipal and private stations.

TABLE 5.—*Number of private and municipal stations, grouped according to dynamo capacity, and percentage each group is of total: 1902.*

HORSEPOWER CAPACITY OF DYNAMOS.	TOTAL.		PRIVATE STATIONS.		MUNICIPAL STATIONS.	
	Number.	Per cent.	Number.	Per cent.	Number.	Per cent.
Total	3,620	100.0	2,805	100.0	815	100.0
Under 200	2,262	62.5	1,650	58.8	612	75.1
200 but under 500	864	23.9	700	24.9	164	20.1
500 but under 1,000	226	6.2	201	7.2	25	3.1
1,000 but under 2,000	137	3.8	126	4.5	11	1.4
2,000 but under 5,000	83	2.3	81	2.9	2	0.2
5,000 and over	48	1.3	47	1.7	1	0.1

More than one-half of the private stations and three-fourths of those operated under municipal control had a dynamo capacity of less than 200 horsepower. A dynamo capacity of less than 500 horsepower was reported for 86.4 per cent of all central electric stations, 83.8 per cent of the stations operated under private ownership, and 95.2 per cent of the stations operated under municipal control. Of the total number of private stations 7.2 per cent had a dynamo capacity of between 500 and 1,000 horsepower, while 3.1 per cent of the municipal stations were included in this group. The dynamos of only 1.7 per cent of the municipal stations and 9.1 per cent of the private stations had a horsepower capacity exceeding 1,000.

In 3,308 stations the dynamos were operated by the use of steam or steam and water power. In a number of cases the steampower was merely auxiliary to the waterpower, being used only when the waterpower was not available. There were 312 stations in which the machines were operated by the use of waterpower exclusively. These stations had 612 water wheels with a stated capacity of 217,261 horsepower and a dynamo capacity of 171,988 horsepower, the kilowatt hour output of current for the year being 258,698,131.

Concentration in large cities.—For each group of cities with a population of more than 5,000 the percentage of private plants is greater than that for municipal stations. The importance of the industry in cities having a population of 500,000 and over is brought out quite forcibly by the following table, which shows the leading items by cities:

TABLE 6.—CENTRAL ELECTRIC STATIONS IN CITIES HAVING A POPULATION OF 500,000 OR OVER: 1902.

	Total.	New York.	Chicago.	St. Louis.	Boston, Philadelphia, and Baltimore.
Number of stations	30	7	9	5	9
Stock issued	$116,001,550	$61,744,600	$11,954,300	$6,400,000	$35,902,650
Dividends	$1,909,629	$150,000	$515,982	$30,000	$1,213,647
Bonds outstanding	$97,959,002	$50,246,000	$9,508,000	$5,000,000	$33,205,002
Cost of construction and equipment	$111,004,658	$41,667,897	$24,399,685	$12,050,313	$32,886,763
Gross income	$20,956,944	$9,847,215	$3,543,737	$1,270,573	$6,295,419
Income from sale of current	$20,909,520	$9,836,266	$3,543,737	$1,267,819	$6,261,698
Arc lighting	$6,428,993	$2,811,723	$1,147,699	$330,369	$2,139,202
Incandescent lighting	$10,988,025	$5,231,102	$1,859,148	$592,150	$3,305,625
All other electric service	$3,492,502	$1,793,441	$536,890	$345,300	$816,871
Income from all other sources	$47,424	$10,949	.....	$2,754	$33,721
Total expenses	$17,376,301	$8,628,894	$2,466,628	$1,153,383	$5,127,396
Salaries and wages	$4,749,167	$2,184,629	$745,401	$389,669	$1,429,468
Cost of supplies, materials, and fuel	$4,369,550	$2,252,614	$741,447	$366,721	$1,008,768
Rents and miscellaneous expenses	$3,547,438	$1,718,351	$511,536	$140,993	$1,176,558
Interest on bonds	$4,710,146	$2,473,300	$468,244	$256,000	$1,512,602
Salaried officials and clerks:					
Number	1,022	348	267	80	327
Salaries	$1,154,882	$368,868	$278,873	$101,584	$405,557
Wage-earners:					
Average number	4,799	2,358	624	390	1,427
Wages	$3,594,285	$1,815,761	$466,528	$288,085	$1,023,911
Horsepower of power plants	261,640	111,880	46,885	21,052	81,823
Horsepower of generating plants	224,054	76,579	48,623	21,383	77,469
Output of stations in kilowatt hours, total for year	368,632,306	153,288,077	67,479,260	28,578,460	119,286,509
Miles of mains and feeders	17,599.95	4,193.19	1,606.72	812.67	10,987.37

The 30 stations reported from these 6 cities had a notably large proportion of the investment and equipment of the industry as a whole. Out of a total of $504,740,352, given as the cost of construction and equipment for all the central stations of the country to date, $111,004,658, or over 20 per cent, was returned for these cities, while of the gross income of $85,700,605, $20,956,944, or very nearly 25 per cent, was returned for them.

The same concentration of investment relative to population is shown by a study of Table 66. Thus New York state, with only 256 stations, but with a population in 1900 of over seven millions, reported a cost for construction and equipment of $112,998,778. Pennsylvania, with a population of 6,302,115, had only 279 stations, but reported a cost for construction and equipment of $41,579,338. It will be seen that the status of the industry as to amount of investment bore a closer relationship to density of population than to the mere number of stations, since Illinois, which led in number with 346 stations and had 4,821,550 inhabitants, reported but $38,329,275 as the cost of construction and equipment. Michigan, with 201 stations, reported $11,559,169, and Indiana, with 180, reported $6,706,510. In the last two states, however, there was a liberal sprinkling of municipal plants, Michigan having 81 and Indiana 62, which would swell the gross totals.

Character of service.—The different purposes for which private and municipal stations supply current are shown in Tables 69 and 79 by the number of stations in the states and territories. The totals for the United States are summarized in the following table:

TABLE 7.—*Number of private and municipal stations, classified according to character of service: 1902.*

CHARACTER OF SERVICE.	Total.	Private stations.	Municipal stations.
Arc lighting:			
Commercial or other private	2,020	1,667	353
Public	2,522	1,810	712
Incandescent lighting:			
Commercial or other private	3,484	2,752	732
Public	2,491	1,889	602
Motor power:			
Stationary	1,093	975	118
Electric railway	159	157	2
All other service	161	152	9

It is evident from Table 7 that the principal business of central electric stations is to supply current for illumination. Eleven of the stations under private ownership furnished current for public lighting exclusively, and all under municipal control supplied current for that purpose. In the earlier days of the industry nearly all the stations were installed for the purpose of furnishing arc lighting, but the change that has come over the industry is indicated by the table, which shows that, of the 3,620 stations, 3,484 were engaged in commercial or other private incandescent lighting. As to arc lighting, 2,522 stations supplied public or street circuits, while 2,020 furnished current for commercial or other private arc service.

Of the private stations, 21 reported the sale of current for arc lighting exclusively, 526 for incandescent lighting exclusively, and 18 for power purposes exclusively. Of the municipal stations, 61 reported current for arc lighting only and 80 for incandescent lighting only.

While municipal stations were in most cases established primarily to supply street lights where none existed before, or to replace service for which private stations were believed to be charging too high rates, such plants now engage in a general illuminating business, also, and in 1902, all but 77 of them sold current to private consumers. With regard to the stations reporting current for power purposes only, it is to be borne in mind that in connection with power transmission work a separate class of stations is springing up, generating current for customers at remote points, without any regard to the use that is to be made of it, and without coming in direct relationship with the individual consumers. Their function as electric light plants has become merged in a much wider one. These stations may be compared to wholesale producers, while the companies or substations receiving the current in bulk and subdividing it may be compared to jobbers and retailers. One of the results of this tendency is that power transmission schemes have been made the means of unifying and bringing together under one management a number of public service electric enterprises, some of which would have been menaced by the new competition and by current generated more cheaply than the older conditions permitted. In this work we have again an industrial parallel with large manufacturers who operate their own factories, establish or buy up stores in the leading cities, and dispose of their goods directly to the public.

Municipal stations are engaged in both kinds of lighting, but the proportion engaged in public arc lighting is very much larger for them than for private stations. In other words, while 1,810, or 64.5 per cent, of the private stations supplied public arc lights, 712, or 87.4 per cent, of the municipal plants did this class of work. The tables are decidedly turned, however, when attention is directed to the statistics as to the supply of motor power. Of the stations, 1,093 supplied current for stationary motors, and 159 furnished current for electric railways. From an inspection of the table it is seen that nine-tenths of the stations furnishing this service were private, which is a striking evidence of the fact that as a rule municipal stations are restricted to illumination and do not operate their plants in the daytime. Only 118 municipal plants supplied current to stationary motors, and only 2—1 at Riverside, Cal., and 1 at Hannibal, Mo.—furnished electric railways with power. It may be questioned whether there were any cases in which current for motors was required from the municipal plants after daylight hours, and the obvious inference is that where no current was furnished for power purposes the plants did not operate what are known as "day circuits." This simple fact is in itself a sign of the conditions under which municipal plants operate, showing that the great majority of them are not only small, but are in communities where the demand for current for power purposes in the daytime is so insignificant as not to make it worth while for the plant to run from sunrise to sunset.

The "all other service," referred to in Table 7, relates to service supplied for the miscellaneous purposes indicated in the following statement:

Miscellaneous service.

CHARACTER OF SERVICE.	Total.	Private stations.	Municipal stations.
Charging telephone exchanges	4	3	1
Charging batteries for boats	3	2	1
Charging other batteries	6	5	1
Charging automobiles	26	23	3
Pumping	58	53	5
Hot water heating	6	6	.....
Steam heating	45	42	3
Electric heating	31	29	2
Hot water	2	2	.....
Steam	26	23	3
Electric current	64	60	4
Nickel plating and electroplating	3	3	.....

In addition to the revenue obtained from supplying electric current or service for the purposes indicated in the above statement, a number of the central stations derived revenue from miscellaneous sources, such as the rent of lamps, poles, wires, meters, motors, and conduits; also from furnishing current for medical and dental purposes, welding of carriage tires, etc. A number of stations furnished current on the meter basis entirely, and no record was made of the purposes for which it was used; therefore the foregoing can not be considered a complete list of the uses to which current was applied during the year.

Work of pioneer stations.—The pioneer arc lighting stations were almost wholly restricted to operation after dark. Although for several years attempts were made to introduce motors on their circuits, all of the conditions were distinctly unfavorable. While it was possible to operate lamps out of arm's reach on tall poles with currents of pressure highly dangerous to life, it was found impossible to surround motors using current of the same tension with sufficient safeguards, and, moreover, the motors were liable to frequent interruption for technical reasons which need not be discussed here. With the introduction of incandescent lighting, however, for which the circuits are operated in parallel rather than in series and depend not upon high tension current but upon current of such low pressure that it can be safely introduced anywhere, the motor industry as associated with central stations took a tremendous leap forward, so that in the year under report the supply of power current constituted a vital portion of the central station business in any community, even one of ordinary size. Electric motor service, whether for factories or for electric railways, is required from early daylight until dusk and often through the night hours, whereas lighting, except in the case of street arc light circuits furnished all night, is normally restricted to a few hours in the evening, and possibly one or two hours in the morning during the winter. Many critics and authorities are of the opinion that successful as the

electric lighting industry has proven to be, it could hardly have survived, and certainly could not have attained its present proportions in so short a space of time, if the electric motor had not come to the support of the electric lamp.

Places served exclusively by municipal stations.—The real value of municipal plants in small communities is best brought out by the following table, which presents the leading items, by states, for stations in places served exclusively by municipal stations:

TABLE 8.—STATISTICS OF STATIONS IN CITIES AND TOWNS SERVED EXCLUSIVELY BY MUNICIPAL STATIONS, BY STATES: 1902.

STATE OR TERRITORY.	Number of stations.	Population.	Cost of construction and equipment.	INCOME FROM SALE OF CURRENT FOR—				Salaries and wages.	Cost of supplies and materials, not including fuel.	Cost of fuel.	Miscellaneous expenses.	HORSEPOWER CAPACITY OF—		Output of stations, kilowatt hours, total for year.	NUMBER OF LAMPS.	
				All electric service.	Arc lighting.	Incandescent lighting.	All other electric service.					Steam engines and water wheels.	Dynamos.		Arc.	Incandescent.
United States.	732	2,052,485	$15,369,382	$4,814,568	$1,691,920	$3,049,815	$72,833	$1,354,833	$760,136	$1,124,403	$327,980	122,880	114,105	148,913,431	28,631	1,465,582
Alabama	9	14,664	110,290	44,974	13,528	31,266	180	9,960	5,161	11,861	2,000	935	873	1,053,002	254	8,385
Arkansas	7	12,935	75,120	31,031	8,077	22,654	300	8,915	4,512	10,610	2,330	840	662	838,965	115	7,043
California	8	36,571	391,081	113,171	25,103	74,856	13,212	30,454	23,929	17,817	7,338	2,035	1,928	2,329,145	323	29,491
Colorado	2	1,402	14,940	5,526	720	4,806	.....	1,620	264	1,980	644	120	94	86,230	12	955
Connecticut	3	15,552	135,332	45,936	15,911	27,481	2,544	10,705	5,537	11,448	2,383	900	520	843,844	249	11,369
Delaware	6	13,036	83,562	26,599	3,341	23,258	.....	8,019	5,730	5,650	1,948	812	700	1,238,525	100	7,445
Florida	4	10,112	48,698	23,752	7,157	16,595	.....	6,697	1,944	10,627	858	435	360	420,433	104	4,080
Georgia	17	47,587	330,992	118,460	44,344	74,116	.....	30,175	23,023	23,653	3,671	2,638	1,961	3,299,946	632	25,475
Idaho	1	1,262	6,930	5,652	840	4,812	.....	2,970	1,060	.....	.....	.....	90	235,790	14	1,033
Illinois	67	135,070	1,151,375	352,427	111,473	240,686	268	105,936	33,120	103,698	24,809	9,240	8,356	9,648,317	1,809	116,226
Indiana	52	163,618	1,188,140	404,991	182,073	220,056	2,862	106,458	69,253	86,071	24,973	10,279	10,388	16,674,275	2,968	123,124
Iowa	36	80,374	669,108	224,361	37,992	184,383	1,986	60,033	28,062	64,970	16,300	5,751	5,067	6,093,089	703	77,501
Kansas	9	32,559	134,213	38,461	21,906	15,666	889	11,365	8,324	5,516	2,838	1,200	1,002	1,323,356	410	8,713
Kentucky	6	31,557	186,186	49,731	27,556	20,675	1,500	15,459	6,950	9,523	2,954	1,640	1,423	2,894,800	493	11,385
Louisiana	10	30,676	207,600	75,516	18,942	54,561	2,013	24,906	14,348	15,641	4,545	1,380	1,354	2,594,410	223	15,692
Maine	1	23,761	23,000	9,600	9,600	.....	.....	4,264	1,122	.....	200	250	160	522,680	192	.....
Maryland	2	3,551	16,050	5,062	612	4,450	.....	1,818	609	1,620	32	135	113	148,920	17	1,510
Massachusetts	17	151,407	1,227,261	264,922	96,486	164,660	3,776	87,271	49,160	56,521	37,296	6,255	6,551	4,195,074	1,731	94,439
Michigan	74	209,022	1,649,429	453,906	170,769	275,613	7,524	133,570	66,170	101,711	31,918	14,321	12,055	16,516,530	3,412	175,561
Minnesota	69	133,612	1,114,440	407,557	104,302	300,585	2,670	106,605	62,854	112,137	22,251	9,363	7,972	11,081,790	1,687	136,590
Mississippi	18	40,406	303,959	115,319	32,436	81,224	1,659	29,427	21,286	27,739	4,152	2,885	2,479	3,312,403	450	27,205
Missouri	39	94,593	642,353	194,573	62,279	128,816	3,478	49,685	21,888	58,494	11,268	5,573	4,850	5,771,412	998	51,886
Montana	1	1,938	32,000	16,208	4,000	12,148	60	3,204	2,910	3,264	1,390	250	1,450	718,320	43	2,825
Nebraska	10	24,535	119,834	45,082	11,596	33,045	441	12,152	7,053	11,341	1,791	1,206	1,159	1,363,275	275	18,626
New Hampshire	1	2,390	9,800	3,250	.....	3,250	.....	600	2,218	.....	.....	150	100	324,120	.....	1,664
New Jersey	4	10,868	193,465	42,653	11,200	31,368	85	9,221	2,631	7,972	2,208	1,085	1,463	877,095	170	16,160
New York	25	81,929	577,820	166,416	85,589	79,496	1,331	49,467	23,899	45,316	13,951	5,119	4,343	5,182,605	1,299	55,815
North Carolina	15	41,188	211,432	87,386	40,456	46,750	180	21,164	13,639	20,792	3,115	2,030	1,929	2,523,080	609	19,981
North Dakota	7	10,632	83,965	47,444	10,185	37,259	.....	12,570	3,018	17,473	1,895	820	511	1,107,045	108	9,960
Ohio	82	211,651	1,723,072	610,395	271,145	331,724	7,526	169,327	91,283	135,211	30,770	15,601	15,261	23,419,559	4,479	163,587
Oklahoma	2	4,732	30,338	13,761	3,408	10,353	.....	4,320	1,224	3,207	1,122	362	220	216,080	40	3,500
Oregon	6	6,102	49,038	21,320	3,776	17,544	.....	5,540	1,447	6,717	1,449	313	358	550,930	40	3,411
Pennsylvania	30	94,898	579,937	168,559	78,914	87,548	2,097	56,690	29,472	38,417	15,114	4,785	4,633	5,991,988	1,345	45,305
Rhode Island	1	(1)	22,919	8,769	5,134	3,635	.....	2,330	1,803	1,538	1,459	100	125	114,975	55	1,500
South Carolina	8	32,342	130,153	47,007	22,763	24,244	.....	14,557	8,817	14,474	2,595	1,260	1,130	1,853,213	360	10,520
South Dakota	5	9,723	73,057	21,429	4,632	16,797	.....	5,738	5,574	4,617	606	520	628	352,639	66	13,223
Tennessee	16	34,357	182,962	60,967	18,760	41,807	400	16,859	7,368	18,045	1,895	1,936	1,790	2,245,995	390	14,564
Texas	4	31,937	106,938	70,360	14,045	50,885	5,430	21,055	17,198	11,648	6,055	1,675	2,275	1,456,120	236	16,672
Utah	1	2,636	9,499	2,870	20	2,850	.....	1,560	153	.....	184	125	47	92,746	1	1,035
Vermont	11	11,578	352,449	46,550	2,825	38,405	5,320	14,520	2,977	1,152	6,729	3,461	2,420	3,768,260	85	33,325
Virginia	9	44,967	193,649	49,435	29,396	19,558	481	14,235	6,766	8,659	3,814	1,030	1,262	1,901,097	431	7,212
Washington	7	50,008	533,880	147,380	43,609	99,150	4,621	39,987	62,923	7,410	16,098	590	632	938,415	967	36,084
West Virginia	4	3,623	28,466	9,599	4,130	5,469	.....	3,680	964	3,220	526	351	250	331,893	81	2,556
Wisconsin	26	57,134	414,650	116,201	30,890	85,311	.....	29,745	12,498	26,643	10,506	3,124	3,161	2,461,045	655	52,949

[1] Population not reported separately.

This table shows the statistics for 732 stations operated in that number of communities, in which there was no competitive private service. It would appear that in all probability a great many if not all of these places would have gone without electric lighting had the supply been left to private enterprise seeking a return upon its investment. These 732 plants constituted 89.8 per cent of all the municipal plants in the country, and their totals formed about 70 per cent of the grand totals under most heads of the various items of equipment, income, expense, and output.

The population served by these stations was 2,052,485, an average of a little over 2,800 per station, and towns of this size rarely offer inducements to private capital, regarded from the per capita basis of consumption of current. These stations also represent a total cost of construction and equipment of $15,369,382, or about $21,000 per station, whereas the average cost of construction and equipment for the 3,620 central stations of all classes was slightly short of $140,000.

The details of the table bring out even more strikingly than the gross figures the smallness of the com-

munities served exclusively by municipal plants. The largest average population per community is shown for Massachusetts, having 17 stations, with an aggregate population of 151,407, or an average of 8,906. The smallest population per community is shown for Colorado, with two municipal stations supplying 1,402 people, or an average of 701 for each station. An average of 5 persons to a family or house would give barely 140 houses. In some of these communities the small number indicates the uninviting prospect for private capital, but discloses at the same time a large amount of public spirit and a determination everywhere to enjoy the latest facilities of modern civilization.

The consolidation of lighting stations and other enterprises.—Reference has been made to the tendency to operate electric light plants in connection with other enterprises. From the reports it appears that at the time of this census 1,465 stations, or about 40 per cent of the total number, were carried on in conjunction with the making of gas, the operation of waterworks, the production of ice, and similar industries. The tendency is toward the massing together of such enterprises, the reason being the greater economy and efficiency resulting from placing a number of small establishments under one competent and well-paid administration. It should again be emphasized that the statistics of such stations relate exclusively to the generation of electric current.

Comparison of gas and electric lighting.—Because of its rapid development, electric lighting has already been placed in sharp competition with other means of artificial illumination, and with one of these, namely, that depending upon the manufacture of gas, it can be compared. The gas industry in the United States is nearly a century old, dating from 1806,[1] whereas central electric stations have been in existence only about twenty-five years, or since 1879, when two or three were to be found in limited operation. The latest available comparative census statistics for the two industries are shown in the following statement:

Comparative summary of central electric stations and gas plants.

	Central electric stations, 1902.	Gas plants, 1900.
Number of establishments	3,620	877
Cost of construction and equipment	$504,740,352	[1] $567,000,506
Cost of supplies, materials, and fuel	$22,915,932	$20,605,356
Salaried officials and clerks:		
Number	6,996	5,904
Salaries	$5,663,580	$5,273,500
Wage-earners:		
Average number	23,330	22,459
Wages	$14,983,112	$12,436,296
Income	$85,700,605	[2] $75,716,693

[1] Capital. [2] Value of products.

While these statistics for the two industries do not cover the same year, the periods reported correspond sufficiently for a general comparison. The totals shown for central electric stations exceed those for the manufacture of gas in all the items except the "cost of construction and equipment," which is compared with the capital reported for the gas companies. The capital stock and funded debt reported for the 2,049 central stations owned by corporations amounted to $627,515,875, and would possibly be the better total to compare with the capital reported for gas companies, namely, $567,000,506. The income for the central electric stations was $85,700,605, while the value of the gas products was $75,716,693.

It is true that in order to give full credit to the electric lighting industry it would be necessary to include the figures for isolated plants, which are usually assumed to be about equal to the central stations as regards extensiveness of equipment. These stations, however, would be offset by a large and unknown number of isolated gas plants. It is contended by authorities in the gas lighting field that these statistics as shown are not so complete a demonstration of commercial parallelism between the two industries as they are assumed to be. According to Brown's Directory of American Gas Companies, there were in the United States in 1903 about 950 gas companies making coal gas and water gas; over 400 natural gas plants supplying towns; and about 150 plants lighting towns by means of acetylene gas or gasoline. Therefore, for 1903–4 there would be about 1,500 gas lighting plants for towns, in this country, although all of them could not be designated as producers of manufactured gas. The natural gas companies, moreover, are highly capitalized, the Philadelphia Company of Pittsburg, for example, having a capital of over $45,000,000. In connection with the investments it may also be pointed out that the dividends paid by central stations averaged 1.7 per cent, and the interest on bonds, 4.7 per cent, while for the gas companies the rates were 4.2 per cent on stocks and 4.9 per cent on bonds.

The following table gives the relative distribution of the central electric stations and gas plants in cities of different population, and is very interesting in its revelation of the wider spread of electric stations:

TABLE 9.—*Number of central electric stations and gas plants in places classified by size.*

POPULATION OF PLACES IN WHICH LOCATED.	Central electric stations, 1902.	Gas plants, 1900.
Total	3,620	877
Under 5,000	2,714	200
5,000 but under 25,000	675	484
25,000 but under 100,000	128	124
100,000 but under 500,000	73	39
500,000 and over	30	30

In connection with this table it may be stated that in the United States in 1900 there were 827 cities and towns in which one or more gas plants were in opera-

[1] Twelfth Census, Vol. X, page 713.

tion, while in 1902 there were central electric stations in operation in all but 153 of these places. It will be observed from the table that 75 per cent of the central electric stations and 22.8 per cent of the gas plants were in places of less than 5,000 inhabitants. This, however, does not reveal the full extent of the benefit conferred by electric methods, the area of distribution from gas works being necessarily limited by physical and economic considerations, so that one gas plant can not supply more than three or four communities, while the electric lighting station can and often does supply light, heat, and power to many towns and villages scattered over many square miles of territory.

Combination of gas and electrical interests.—In many cities the competition of the gas and electric industries is undoubtedly as keen now as it was at any time during the last twenty-five years. On the other hand, in several hundred towns and cities the gas and electric lighting interests have been brought together and consolidated, very often on the initiative of the older gas interests, which have thus remained in control of the entire private lighting from a central source. There is a decided tendency toward this form of consolidation. In some places it already embraces also the street railways and the water supply service, while one or two instances could be quoted where the telephone systems have also been taken into the combination. The most conspicuous instance of united ownership of gas plants and central stations is to be found in New York city, where the entire system of electric lighting is under the absolute control of the Consolidated Gas Company of New York.

This tendency toward combination has been stimulated frequently by the insensate competition between the managements of the two methods of illumination, but is also due in large measure to the recognition of the fact that electricity, as it emerged from the earlier stages of experimentation, gave every promise of becoming a stable and lucrative industry which could be operated quite advantageously along the lines already proved best in the development of gas lighting.

Comparison with census of 1890.—It is perhaps unfortunate that the figures for central electric stations are not as a whole subject to any comparison with those of any previous census period. The only figures for the previous decade that are available for comparison apply to the state of New York, for which a partial canvass was made in the census year 1890. As a matter of fact, the industry had not developed sufficiently in 1880 to be included as a whole in the census report for that year. The statistics reported at the censuses of 1890 and 1902 for this industry in the state of New York are summarized in Table 10, and are a further indication of the rate of increase maintained by the industry during the past twelve years.

TABLE 10.—*Comparative summary—central electric stations in New York state: 1902 and 1890.*

	1902	1890	INCREASE.	
			Amount.	Per cent.
Number of stations	256	139	117	84
Cost of construction and equipment	$112,998,778	$31,183,618	$81,815,160	262
Total income	$16,854,839	$4,174,534	$12,680,305	304
From arc lighting	$4,944,575	$2,272,374	$2,672,201	118
Private	$1,818,499	$951,810	$866,689	91
Public	$3,126,076	$1,320,564	$1,805,512	137
From incandescent lighting	$7,976,232	$1,585,834	$6,390,398	403
Private	$7,540,994	$1,522,316	$6,018,678	395
Public	$435,238	$63,518	$371,720	585
From motor service	$2,396,046	$192,754	$2,203,292	1,143
From miscellaneous service	$1,537,986	$123,572	$1,414,414	1,145
Salaries and wages	$3,904,706	$1,375,861	$2,528,845	184
Supplies and materials	$2,433,526	$467,842	$1,965,684	420
Fuel	$1,494,043	$513,794	$980,249	191
Miscellaneous expenses	$2,662,001	$720,128	$1,941,873	270
Total horsepower of power plants	323,413	59,512	263,901	443
Total horsepower of dynamos	251,007	41,844	209,163	500
Lighting service:				
Total number of arc lamps	59,130	19,834	39,296	198
Private	26,806	8,885	17,921	202
Public	32,324	10,949	21,375	195
Total number of incandescent lamps	3,705,525	286,935	3,418,590	1,191
Private	3,561,934	280,989	3,280,945	1,168
Public	143,591	5,946	137,645	2,315

The totals for 1890 do not include the report for a central station operated by the municipality of Dunkirk. The totals for 1902 include the returns for 28 stations operated by municipalities. Of these, 3 were installed under private ownership and were so reported at the census of 1890, but subsequently came under municipal control. The rate of increase for the number of stations was 84 per cent, but the rates for cost of construction and equipment, income, expenses, horsepower capacity, and services were much greater, since the totals for each of these items had more than doubled during the twelve years. The average horsepower capacity of the 139 stations reported in 1890 was only 428 for the power plant and 301 for the generating plant, as compared with 1,263 and 980, respectively, for the 256 stations reported in 1902. In 1890 the average number of arc lamps per station was 143 and of incandescent lamps 2,064, while in 1902 these averages had increased to 231 and 14,475, respectively. Since the density of population is the principal inducement to the establishment of central electric stations, it is probable that the increase in New York is larger than that in other states, and therefore should not be accepted as a true indication of the rate of increase for the entire country.

CHAPTER III.

FINANCIAL OPERATIONS.

I.

CAPITAL STOCK AND FUNDED DEBT.

Private stations.—The number of central electric stations owned and operated by corporations, the amounts of their common and preferred stock authorized and issued, the amount of their outstanding bonds, the amount of interest paid on bonds during the year, the amount of dividends on both classes of stock and the total capital stock and funded debt are shown by states and territories in Table 69. For more convenient reference, the totals for the United States are given in the following table:

TABLE 11.—*Capital stock and funded debt—incorporated companies: 1902.*

Total capital stock and funded debt authorized	$743,296,266
Total capital stock and funded debt issued	627,515,875
Capital stock:	
Authorized	435,178,372
Issued	372,951,952
Dividends	6,189,837
Funded debt:	
Authorized	308,117,894
Outstanding	254,563,923
Interest	12,118,740

The total capital stock and funded debt authorized amounted to $743,296,266, but the amount issued was considerably less, being $627,515,875. Of the total amount authorized, $435,178,372, or 58.5 per cent, was capital stock, and $308,117,894, or 41.5 per cent, was funded debt. Of the total authorized capital stock, $372,951,952, or 85.7 per cent, had been issued at the end of the year covered by the report. Of the capital stock issued, $23,871,671, or 6.4 per cent, was preferred stock and $349,080,281, or 93.6 per cent, was common stock.

The common stock on which dividends were paid during the year amounted to $126,284,352, or only 36.2 per cent of the total issue, the dividends paid amounted to $5,560,341, or an average rate of 4.4 per cent on all the stock of that class paying dividends. The proportion of preferred stock paying dividends was somewhat higher, the value of the stock being $12,197,463, or 51.1 per cent of the amount issued; the dividends amounted to $629,496 and were at a rate of 5.2 per cent. Thus common stock to the value of $222,795,929 and preferred stock to the value of $11,674,208 paid no dividends. Only 589 companies reported that dividends were paid on either common or preferred stock; 561 paid dividends on common stock; 71 reported an issue of preferred stock, and 41 the payment of dividends on such stock; while but 13 paid dividends on both their common and their preferred stock. Of the funded debt authorized, $254,563,923, or 82.6 per cent, was outstanding at the end of the year. With regard to bonded indebtedness, 795 companies reported interest on $250,535,749, the rate averaging 4.8 per cent. It will be seen that whatever was the fate of a large proportion of the common and preferred stock, practically the whole of the fixed charges obligations were met, as there was indicated a default upon only $4,028,174 out of a total of $254,563,923 outstanding.

The total cost of construction and equipment of the 2,049 companies included in these totals amounted to $473,048,734, and was 75.4 per cent of the par value of the capital stock and funded debt of these companies.

Overcapitalization.—An inference fairly derivable from a study of these figures is that the electric light industry has, like some others, suffered from overcapitalization (this term being used in its broadest and most comprehensive sense), and this inference would appear to be justified by further figures resulting from the inquiry.

In such a new industry as that of electric light and power, and especially since the industry is complicated by being carried on frequently under the same roof or the same management with other enterprises, it is naturally very difficult to determine the exact nature of the overcapitalization or even, in fact, that overcapitalization exists to any serious extent. Of the 2,049 central stations operated under private ownership and controlled by corporations, 747 were carried on in connection with gas plants, waterworks, ice plants, sawmills, and other industries. Just as, in such cases, a great deal of the plant is operated and used indifferently for all the systems, as, for example, the same boilers and steam engines or the same water wheels, so also it is quite a common thing for the capital stock and bonds to cover the entire interests of a corporation, there being no separate issue for the electric part of the composite enterprise. This is particularly true of corporations that were originally chartered for the manufacture of gas or the operation of waterworks and later furnished themselves with an electric equipment, although in many instances an issue of bonds has been made in taking over an electric light plant already established—these bonds either serving to raise the money required for the transfer or being given in exchange for some or all of the stock of the electric light shareholders. Under these conditions it is obvi-

ously impossible to obtain an accurate enumeration of the capital stock or funded debt of electric light stations exclusively, and the amounts charged to stations subject to these conditions were therefore estimated. The capital stock and bonds reported in Table 69 may, however, be accepted as representing, with fair and close approximation, the capitalization of the corporations engaged in central station business in the United States.

Return on investment.—The rate of return on the capital stock and investment of some of the oldest central station companies was and has remained far larger than is indicated by the average figures which have been cited above, figures which, if accepted as the only criterion, might well act as a deterrent against venturing into an industry generally so unremunerative. It must be remembered, however, that in some cases qualifications and explanations would forbid a pessimistic view being taken. With barely two decades of continuous existence, the industry is still so young that, taken as a whole, it may be spoken of as being even yet in its formative period, and a nascent period is almost invariably one of unavoidable waste and extravagance. However, a great deal of experimental work has doubtless been done once for all.

These statistics show another phase of the general tendency to inflation by overcapitalization upon the basis of large earnings in good times, with the result that a large part of the nominal capitalization is unable to pay dividends, while the rates for the sale and supply of current, etc., are often kept unnecessarily high. Those familiar with the history and development of the central station industry are aware of the prolonged and expensive period of reconstruction that has led up to the present era of modernized stations, which, even as they stand, do not in many respects represent finality, but in frequent instances will at an early date have to pass into the scrap heap under the pressure of competition or on account of the production of apparatus of such superior efficiency and economy that no manager would consider he was doing his duty if he did not immediately adopt it. In the technical part of this report various aspects of this evolution in central station work will be more minutely considered. It will suffice here to note in connection with questions of capitalization, that since most of the central stations have been, until recent years, almost entirely lacking in a proper depreciation account, the frequent reconstruction and renewals of their systems have necessarily been charged to the capital account. Instances could be cited from some of the largest stations in the country where, as a result of inevitable changes in the system, apparatus for which the average rate of depreciation might be 4 or 5 per cent per annum has been thrown out or disposed of for a nominal sum at the end of four or five years, so that even had there been a depreciation account and a scientific method of "writing off," the newer additions to the plant would be under the burden of maintaining the business of the company and earning its entire income from operation without the aid of the older plant still carried on the books, and equally represented in the capital account. In this connection it might also be pointed out that some corporations, organized to take over central stations, have been capitalized rather on the basis of future earnings than on the actual earning capacity at the time of the reorganization.

Preliminary expenses provided for out of capitalization.—It is only fair to the corporations whose reports are under review to note also the fact that although the cost of construction and equipment has been compared with the capitalization with the result of revealing generally a gap between the two, the mere compilation of the items entering into the physical constitution of a central station is very far from doing justice to all the elements that go to make up such an industry, whether as an investment or as a specimen of engineering. It is needless to allude to the preliminary work—often very expensive and laborious—connected with the organization of the company and the securing of necessary legislation, franchises, rights of way, concessions, and other moves that have to be made before the company can come into being as a creation of the state and a servant of the public. The central station is, however, much more than a financial corporation, and it is upon the preliminary engineering in its work that a large amount of expense is concentrated. This fact is not usually a matter of public information. Among such items might be mentioned the careful and elaborate canvass that it is the custom to make in order to ascertain how much current, how many lights, and how much capacity in horsepower of motors are likely to be called for in the area to be served. Upon the results of the canvass depend not only the amount of capital required and the magnitude of the plant as to the machinery to be installed and the buildings to be put up, but also the size and length of the circuits, whether overhead or underground. It can readily be seen that these determinations are vital to the success of the proposed enterprise, and hence they are made and remade with care which involves a large amount of thought, time, and expense. These remarks are equally true of the central station itself in its equipment and design, and in the decision to adopt or reject certain features upon the best engineering advice. Work of this character must be provided for out of the original capitalization of the company, and such work must also be renewed incessantly after the plant has gone into operation, although at the later stage it can properly be and often is paid for out of the income.

The practice of electric light companies, as well as those engaged in kindred enterprises, varies as to the amount that is properly chargeable to capital account and the amount that should be included under operating expenses and ordinary repairs. Undoubtedly some of the

companies included in these returns have placed themselves in the best position to meet the inevitable reconstruction expenses of their business by making such outlay out of current income, although they thereby lower their rate of dividends and perhaps the public quotations of their stock, rather than by maintaining a high rate of dividends and loading on the ultimate capital account, items which in the aggregate represent a large amount of money and upon which from year to year a larger amount of dividends must be paid.

Capital stock and funded debt, by states.—An examination of the statistics as to capital stock and funded debt for the different states, as shown in Table 69, is instructive, and brings out some interesting points.

The state of New York, as would naturally be expected, stands out conspicuously because of its large proportion of both stocks and bonds issued. It had a total value of $190,300,149, of which $104,245,475 was the value of the capital stock, upon which $682,245 was paid in dividends; and $86,054,674 was the amount of funded debt, upon which $4,195,105 was paid as interest. This amount of slightly over $190,000,000 is more than 30 per cent of the total for the whole country, although the plant and income are by no means in such high ratio. The very large amount of stock, which is almost entirely of the common class, and the small amount of return upon it, are explained chiefly by the fact that in the successive absorptions and consolidations of the lighting interests in Greater New York, stock has been issued in large volume in connection with these transfers of property, and a very small proportion of it had attained the dividend-paying basis at the time when the returns were made.

The total par value of the capital stocks and bonds reported for the state of Pennsylvania was $78,636,619, of which $41,147,450 was capital stock, which paid $679,808 in dividends; and $37,489,169 was bonds, on which interest was paid to the amount of $1,736,324.

The value for New Jersey was $58,844,336, of which $31,174,836 was the value of stock, paying the extraordinarily small amount of $27,080 in dividends; and $27,669,500 was the value of the bonds, paying $1,200,937 in interest. The conditions as to stock issuance in New Jersey would appear to have been governed by the remarkable series of changes and transfers in the northern part of the state which vested in the Public Service Corporation both the electric light and the electric railway system throughout a district that is perhaps the largest in the world to be thus occupied and supplied by one management.

The amount issued in the state of California was $51,058,045, of which $36,897,745 was stock, on which $664,721 was paid in dividends; and $14,160,300 was bonds, on which $691,701 was paid in interest.

In Illinois $35,889,835 had been issued, of which $20,789,535 was stock, on which $579,714 was paid in dividends; and $15,100,300 was bonds, on which $738,977 was paid in interest.

In Ohio the total was $24,839,632, of which $19,299,799 was stock, on which $575,123 was paid in dividends; and $5,539,833 was bonds, on which $266,459 was paid in interest.

The state of Massachusetts furnishes a striking example of the practice of maintaining a fairly good rate of return on stock and keeping the amount of bonds low. The total issue was reported at $21,412,506, of which $16,971,000 was for stock, upon which not less than $1,225,129 was paid in dividends, this being by far the largest amount returned as dividends on stock in any state; while the value of bonds was $4,441,506, on which $247,015 was paid as interest.

Stocks and bonds held by parent companies.—To a large extent the stocks and bonds of these various enterprises are held locally, but no data were obtained on this point. In the initial days of the introduction of electric lighting it was the general practice with the "parent companies," by which name the concerns selling the plant were known, to issue a license for a given city or territory and to take in return for its apparatus and its patent license a certain proportion of stocks and bonds of the local company organized. Hundreds of companies were started on this basis, a part of the capitalization being held at home, while part of it went to the parent companies and was bought from them by bankers. Down to the period included in this report a few of the parent companies continued to hold blocks of stock and bonds obtained originally in this manner; but the practice, which was so universal at one time, has almost entirely died out, and the securities have now passed into the hands of the general public. Boston, New York, Philadelphia, Pittsburg, Cleveland, and Chicago are the principal centers at which such securities have been marketed, and these cities have exchanges upon which such stocks are still most largely listed and where quotations are most readily obtainable. While it would be of great interest to know what net valuation at current market prices was represented by the figures cited above, it is impossible to determine this, because in a great many cases the stocks and bonds of the companies under consideration were not listed or quoted regularly upon any of the exchanges or even dealt in casually on the "curb" or unlisted market.

During the past few years a large number of companies, individually small and not subject to stock exchange valuations, have been brought more readily within the area of open public investment and of financial adjudication as to actual value by the action and formation of large holding companies located chiefly in the cities that have already been mentioned. These holding companies, whose operations are on the increase, make it their business to buy up lighting plants either in selected regions of great extent or through the country promiscuously, when the operators of the

plants are not able to furnish the necessary capital for maintaining and extending the system. When plants are thus brought under one management all the supplies for them are bought in common, and consequently are cheaper; the employees are subject to sharper discipline, and the engineering supervision is more careful than in the separate plants; therefore the plants, as a whole, are likely to be in much better condition and also much more progressive than they were as scattered units in struggling communities. Another advantage gained is that the securities issued in exchange for the stocks, or to raise the money to pay for them, are regularly listed and largely dealt in on prominent exchanges. The same system has been pushed even farther in the combination of electric railways and electric lighting stations, as well as other enterprises of an electric nature; and it remains to be seen how far and how beneficially this tendency can be carried. Its ultimate result will constitute undoubtedly an important chapter of American economic development.

Bonds of municipal stations.—Of the 815 municipal stations enumerated, 656, with an authorized funded debt of $12,625,482, reported $11,609,488 in bonds outstanding. Of these municipalities, 635 reported the payment of interest amounting to $504,805 on bonds to the value of $11,239,588, the average rate being 4.5 per cent on all bonds paying interest. It is to be observed that this rate very closely approximates that paid by the private companies, namely, 4.8 per cent. As a general thing, the rate on funded debt for municipalities is understood to be lower than that which can be obtained by private companies, and this has frequently been advanced as an argument for placing a plant under municipal ownership, since it is reasoned that a cheaper and more economical administration may be obtained thereby. The cost of construction and equipment of the municipal stations is set down as $22,020,473, although it is not to be inferred or understood that the wide difference between the cost of construction and equipment and bonds outstanding is represented by the figures for the 159 plants not reporting bonds outstanding; moreover, no statement is made as to the value of the bonds that were originally authorized and issued for the construction or acquisition of such plants and have since been liquidated and retired.

The largest amount of bonds outstanding for municipal stations was for the state of Michigan, and resulted to a great extent from the large station at Detroit; the amount was $1,833,850, and a total of $79,249 was paid in interest.

II.

COST OF CONSTRUCTION AND EQUIPMENT.

General discussion—private stations.—The cost of construction and equipment as reported for private stations is given by states and territories in Table 69. Similar statistics are shown in Table 79 for the stations owned by municipalities. It should be understood before coming to a discussion of the capital stock and funded debt outstanding in relation to cost of construction and equipment that the capitalization may or may not represent an actual investment of capital. In many instances the stock is not fully paid. The schedule used in collecting statistics from central stations included a series of questions concerning the cost of construction and equipment. The object of these questions was, in part, to distinguish the amount expended annually for the physical maintenance and extension of the system. These questions required separate amounts to be reported for each of the following items: Land, buildings, machinery, tools and implements within stations, electric service construction, lamps, motors, meters, and transformers wired for use, supplies of every kind on hand not enumerated in these items, and miscellaneous. A large number of stations reported that it was impossible to give an itemized statement of this kind, especially where the station was installed and operated in connection with other enterprises or where the present corporation did not build and equip the plant, but purchased it as a whole. Hence, in Table 69, only the total cost to date and for the year are shown, the latter item throwing some interesting light upon the amount of extension and new work occurring during a period of twelve months. The cost of construction and equipment of private stations constituted 95.6 per cent and that of municipal stations, only 4.4 per cent of the total amount, namely, $504,740,352, reported for all stations.

Cost of construction during the year—private stations.—According to the reports received, private stations expended $40,050,613 and municipal plants $1,741,834 in construction and equipment during the year covered by the reports.

A study of Table 69 exhibits some striking variations in the different states as to the amount of expenditure during the year under the head of construction and equipment, the item bearing apparently no relation to the figures which have been discussed as to population and investment, or in general as to equipment. The reason for this is doubtless to be found in the fact that great extensions are rarely made in all the states simultaneously. If they were all to be carried on at once, the electrical manufacturing industry would be under abnormal pressure in some years and would be correspondingly dull in other years. Hence, while the total amounts for the various years may average about the same, considering the natural tendency to increase, the analysis of the amounts would show development to vary from one state to another, year by year, and more particularly from one large city to another. Thus the amount expended for construction and equipment during the year in Pennsylvania was only $3,057,799,

almost exactly the same amount being expended in Illinois, namely, $3,074,117. It is a matter of record that since that time very heavy investments in plants, buildings, etc., have been made in Chicago and in Philadelphia. Massachusetts reported no less than $8,343,437, although the total for the industry from the beginning was only $28,335,006. This was by far the largest amount expended in any state, and would indicate a period of unparalleled activity, with new work going on in almost every community. It was almost twice the amount spent in the state of New York, $4,955,859, and was much larger, also, than the amount spent in California, $5,210,395, where a considerable development was also taking place. Other states in which especial activity during the year was indicated are Iowa, New Jersey, Ohio, Rhode Island, Missouri, Colorado, Texas, and Montana.

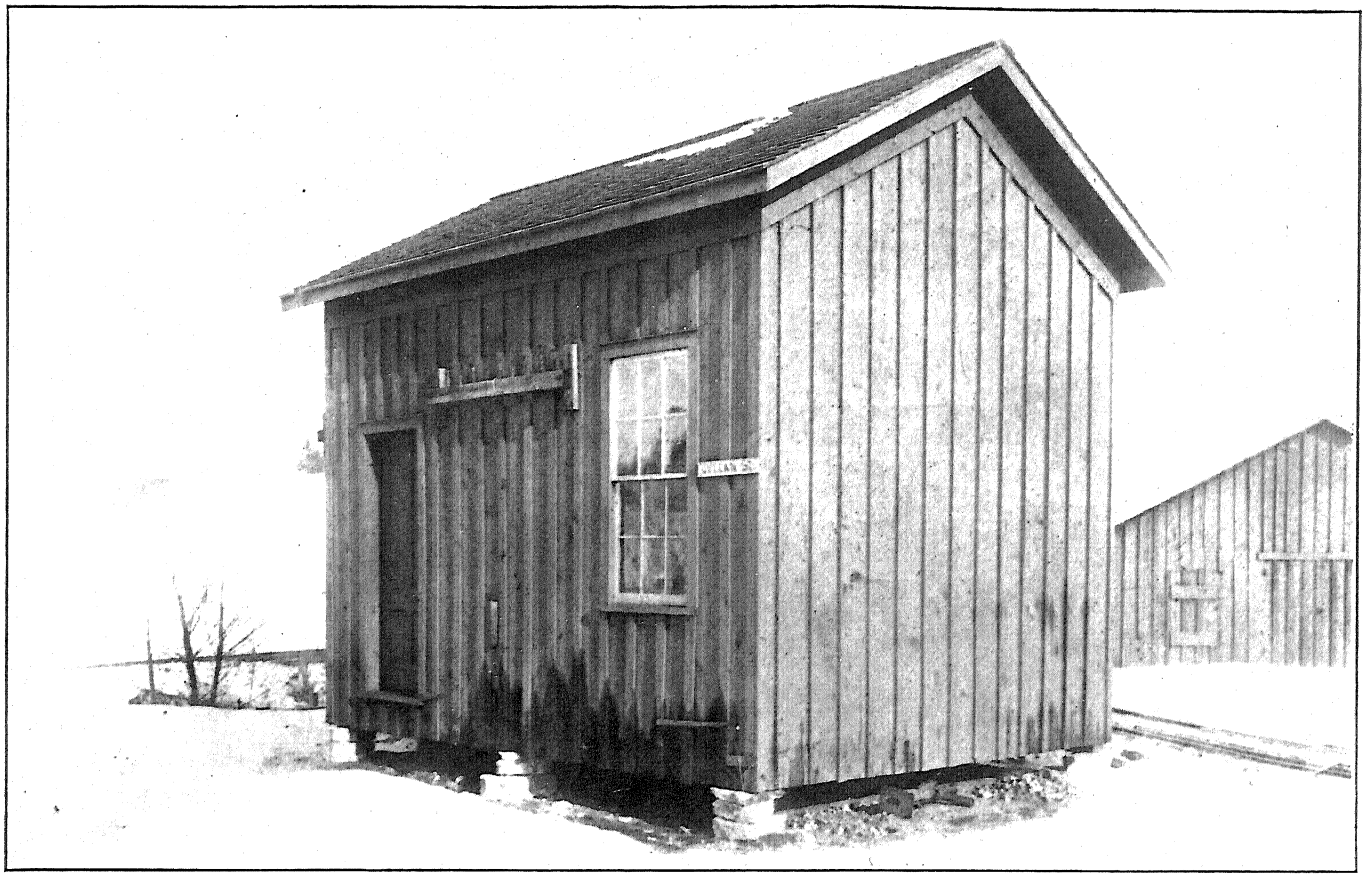
Unit of comparison.—In discussing the financial statistics of central electric light stations, it is by no means easy to find a unit of comparison for the ratio of investment, capitalization, etc. With railways of all kinds one basis of computation is the mileage of track, and a variety of interesting and instructive figures can be worked out upon that basis (sufficient for certain purposes, if checked by other bases and ratios). So far as is known, however, it is impossible to use as a unit of capitalization or investment the miles of circuit which a central station may have installed or with which it may be connected. In fact, outside the mileage of its mains and feeders, it may be questioned whether any large central station management has any except the most general idea as to the miles of wire over which the current it generates may be circulated. In cities of even the most moderate size, it is now the practice to wire new buildings for electric light and service in the same matter-of-course way as they are piped for gas or water supply. It is also true that new factories are planned in such a way that individual tools and whole rooms of machinery may be operated by electric motors, and the circuits must be connected with these motors also. Hence, while the electric light company must know how many lamps or how much horsepower of motors there are in its circuit, i. e., how much apparatus it is contracting to operate, it hardly ever raises the question as to how many miles of circuit there may be in the new service for which it has taken the order. It assumes as a matter of course that the building has been adequately wired, and, in fact, as the current supplied is now metered rather than sold at a flat rate, and as the meters are placed at the entrances to the buildings, the supplying company would be the gainer in the consumption of current if the wire was inadequate in size and if an undue amount of current was therefore consumed in overcoming the disproportionate resistance. Moreover, the proprietor of the building with insufficient wiring would be assuming improper hazards as to the risk of fire. Any consideration, therefore, of electric light capitalization as related to the total mileage of circuit may be dismissed as out of the question.

A test based upon the number of lamps and motors connected is equally invalid, since such figures have more to do with the question of earning capacity and average income than with the investment required or the outlay sustained for the equipment of the power plant and the system as a whole. A rough and ready unit of comparison—though one not to be taken too seriously—is that based upon the horsepower equipment or generating capacity of the central station itself, and from this some interesting data may be derived.

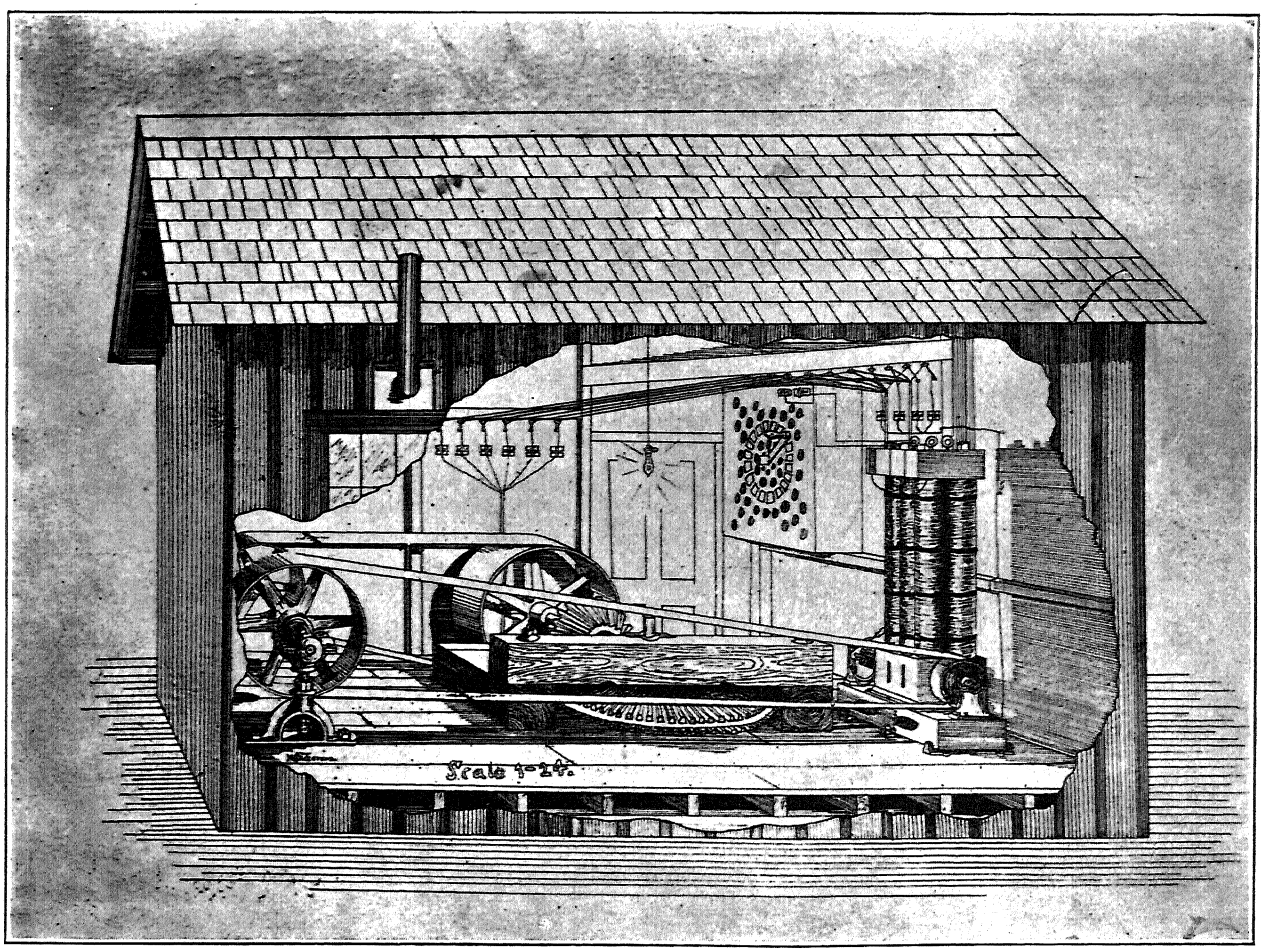
A moment's thought will show that a large part of the outlay on a central station system must necessarily be expended for work outside the four walls of the power house, and that the amount so expended will vary with a number of uncertain factors, particularly those connected with the construction of the distributing circuits. In some cases the circuits are overhead, in others they are underground, and in others, again, there are circuits of both kinds, and as a rule the cost is not the same in any two cases. Among electric engineers and purchasers of dynamo-electric apparatus, it is customary to quote offhand general figures as to the cost per kilowatt of such machinery in the market, but in reality the figures of expense differ according to a variety of important and essential elements, such as the size of the plant, its nature, whether steam or hydraulic, the provision for development and extension, the reserve capacity deemed necessary, the location of the plant, and its accessibility for the delivery of machinery or fuel. It must be understood, therefore, that the total cost embraces these various items and other miscellaneous equipment, the buildings, the cost of constructing overhead and underground circuits, the switchboards in the power house, the substations, and other features without which the plant could not be operated.

Cost of construction and equipment of private stations.—The private stations reported a total dynamo capacity of 1,472,996 horsepower. How much of this was actually in use or available is not known, but for the present purposes it will be assumed that all was available. The total cost of construction and equipment for these stations was $482,719,879. This would give an average outlay of $328 per horsepower of dynamo capacity.

Associating the figures of generating equipment in Table 74 with those of cost of construction and equipment in Table 69, conclusions of the same nature are deduced for several of the states. Thus in New York, with a total cost of construction and equipment of $112,185,829, the dynamo capacity was 245,823 horse-



EXTERIOR OF FIRST EDISON STATION, APPLETON, WIS., 1882.



INTERIOR OF APPLETON PLANT, SHOWING EARLY EDISON DYNAMO AND REGULATING APPARATUS.

Original capacity of the plant only 250 incandescent lamps; plant driven by waterpower. Facsimile reproduction of an old engraving.

power. This gives an average of $456 per horsepower. This average is greatly exceeded by that for the state of New Jersey, where there are no centers of population of the first class, and where, presumably, the cost of installation, regular equipment, real estate, and other items would hardly compare with those in New York. In New Jersey the average was $932 per horsepower. This is an abnormal average, and is presumably accounted for by the fact that a number of the stations have changed ownership, the new owners reporting as the cost of construction and equipment the par value of the stocks and bonds issued in payment, regardless of their market value. The adjacent state of Pennsylvania, although containing the two large cities of Philadelphia and Pittsburg, fell far below either New York or New Jersey, reporting an average of $260 per horsepower. In a number of states the average approximated that for the country as a whole, namely: California, $327; Colorado, $297; Connecticut, $318; Illinois, $314; and Ohio, $320. The average was low for all of the Southern states, except Louisiana, for which it was $644. This high average was probably due to the same causes as those existing in New Jersey.

Cost of construction and equipment of municipal stations.—The statistics of cost have thus far been discussed solely with regard to the central stations operated by private companies. It is only with them that questions connected with capitalization would arise from the standpoint of investment, returns, capacity, etc. It may not be amiss, however, to note incidentally a few of the figures connected with the municipal stations.

Without going into the minute details of an examination of each station, it would be difficult to determine how much of the cost of construction and equipment pertained to what may be spoken of as "live plant," that is, apparatus in present use as distinguished from that which has passed out of service and therefore has no longer a capital value or earning capacity. It appears from the statistics in Table 79 that the cost of the construction and equipment of municipal stations from their origin until 1902 was $22,020,473, while the total dynamo capacity shown in Table 84 was 151,984 horsepower. This would represent an average of nearly $145 per horsepower of generating capacity as the cost of construction and equipment of the plants as they stood at the time of the report. The difficulty of taking this figure as the basis for comparison is shown by the wide variations revealed by the different states in regard to these plants. In the state of Washington, for example, the average was $844 per horsepower, while in Connecticut it was $260, and in California, $210. No other state approximated these figures, although Massachusetts with $187 and Michigan with $175 were considerably above the average. In both New York and Pennsylvania an average of $156 per horsepower prevailed. In Wisconsin and Iowa the average was $132; in Minnesota, $139; in Missouri, $143; and in Illinois, $154. In Ohio and Indiana the averages were considerably below that for the country, that in the former being $114 and in the latter $116 per horsepower.

III.

GENERAL DISCUSSION OF INCOME AND EXPENSES.

Basis of income.—The method of carrying on the business of central stations varied not only with the section of country but with the idiosyncrasies of individual stations, and therefore it was impossible to obtain all the information necessary to prepare an exact income account for the generation and sale of electric current exclusively. It is only within recent years that the distinction between income from sale of current and other income has arisen and has been recognized by central station managers.

At the outset the central station companies undertook to do merely the work connected with lighting—then their sole basis of income—and it is only within a quite recent period that the function of a central station has been regarded as dealing with the supply and sale of current irrespective of the use to which that current may be put and of the apparatus consuming it. Even at the present time it is not well settled among them whether they are selling current for light only or for a variety of uses. But there can be no question as to the fact that as the central station industry expands the managers of a company care less for any particular branch of it, and devote their energies more and more to the efficient generation of current and its economical distribution, leaving it to the consumer to determine to what specific use the current shall be put.

None of the early central stations metered the current, but sold it on a flat rate basis, charging so much per year, per month, or per night for an arc or an incandescent lamp. The conditions of operation rendered it comparatively easy to conduct the enterprise on that happy-go-lucky plan, as the business was restricted almost entirely to arc lighting, the lamps being lighted at a certain hour in the evening and allowed to burn for a definite number of hours, so that the amount of current and service could be roughly estimated. When the incandescent lamp was added to the consumption circuits the attempt was made to place this similarly on an arbitrary scale, predicated upon the number of lamps in the house or building and the plausible number of hours that such lamps might be used. Even to-day, as will be seen later in the discussion of incandescent lighting, such methods are still in vogue. It was soon found, however, especially when electric motors and lamps were employed on the same mains, that the central station must employ a more scientific basis for deter-

mining its income. This led to the invention and perfection of numerous station and house meters for measuring electric current, and these meters were quite generally introduced by all the large stations, so that the tendency of the last few years has been toward the metering of all current and making charges for it upon the basis of the number of units consumed, subject to varying rates of discount or to varying methods of encouraging the customers to patronize the service largely. In this respect electric current supply has been rapidly placed abreast of gas, and as a general thing the charges for both services would appear to be far more precise and accurate than those under the centralized distribution system, which is older than either of them and is used in connection with the supply of water from a common reservoir.

The reports for 380 stations show that some service in the character of a tax was furnished to the municipalities in which they were located. This tribute consisted in the illumination of some or all of the public buildings, the supply of a certain number of lamps, the granting of a special discount on the lamps used by the municipality, or in other ways making a return for the ordinance or franchise by which the private company was granted the right to use the streets. The value of this free service has been estimated at commercial rates, and is included in the income. In some instances a cash compensation of a certain specific amount or a proportion of the gross income was required as a yearly payment. For the census year, 89 stations reported a payment of this character.

Miscellaneous income.—In addition to the income derived from the sale of current for lighting purposes, a considerable amount was received from "all other electric service," which included stationary motor service, railway motor service, electric heating, charging automobiles, etc., and a comparatively small amount from "all other sources," which included the renting of motors, meters, and conduits, the sale of steam and water power, the wiring of houses, the sale of supplies, pumping, steam heating, hot water heating, interest on deposits, and a variety of miscellaneous work. In some cases the stations still do a considerable commercial business of this character, the practice varying greatly, however, in this respect. The pioneer stations, in the absence of the contracting and installing electric firms now so numerous, were compelled to do the bulk, if not all, of their own construction work, but to-day every large city and indeed every community of fair size has its construction and supply house for electric work, to which is relegated to an increasing degree all work beyond that of generating current. Some of the stations included in this report do a considerable construction and supply business, in such a way as to render it out of the question to segregate the incidental expenses so as to show the cost of station supplies used, as distinguished from those sold commercially.

General statistics of income.—Table 12 gives a condensed summary of the income from the various sources, and shows the totals for the United States and the amounts for private and municipal stations with the percentage which each is of the total. In the case of municipal stations, as already noted, the income from public service was necessarily estimated.

TABLE **12.**—*Income—private and municipal stations, and percentage each class is of total: 1902.*

	Total.	PRIVATE STATIONS.		MUNICIPAL STATIONS.	
		Amount.	Per cent.	Amount.	Per cent.
Total	[1] $85,700,605	$78,735,500	91.9	[1] $6,965,105	8.1
Arc lighting	[1] 25,481,045	22,091,800	86.7	[1] 3,389,245	13.3
Incandescent lighting	[1] 44,657,102	41,297,484	92.5	[1] 3,359,618	7.5
All other electric service	14,048,458	13,960,465	99.4	87,993	0.6
All other sources	1,514,000	1,385,751	91.5	128,249	8.5

[1] Includes estimated income from public lighting.

Of the total income, $85,700,605, not less than $78,735,500, or 91.9 per cent, was reported for private stations and $6,965,105, or 8.1 per cent, for municipal stations. The rate of income of private stations exceeded this rate in all branches of electric service except arc lighting, for which the private stations reported only 86.7 per cent of the total.

Table 13 shows the percentages that the receipts from the different sources form of the total income for all stations and for private and municipal stations, respectively.

TABLE **13.**—*Percentage that each item of income is of total—private and municipal stations: 1902.*

	Total.	Private stations.	Municipal stations.
Total	100.0	100.0	100.0
Arc lighting	29.7	28.1	48.7
Incandescent lighting	52.1	52.4	48.2
All other electric service	16.4	17.7	1.3
All other sources	1.8	1.8	1.8

Although the practice of supplying current for motive power and other uses had grown rapidly, the supplying of current for light was still preponderatingly the business of both private and municipal stations. Of the total income, $70,138,147, or 81.8 per cent, was directly derivable from lighting. The private stations obtained 80.5 per cent and the municipal stations 96.9 per cent of their income from this source.

General statistics of expenses.—The amounts expended for salaries, wages, supplies, materials, fuel, and miscellaneous expenses are given by states in Tables 70 to 72 and 80 to 82. The totals are presented in Table 14, which shows also the proportion represented by private and municipal stations, respectively. These comprehensive divisions of expense will be analyzed later.

TABLE 14.—*Expenses—private and municipal stations, and percentage each class is of total: 1902.*

	Total.	PRIVATE STATIONS.		MUNICIPAL STATIONS.	
		Amount.	Per cent.	Amount.	Per cent.
Total	$68,081,375	$62,835,388	92.3	$5,245,987	7.7
Salaries and wages	20,646,692	18,766,970	90.9	1,879,722	9.1
Cost of supplies, materials, and fuel	22,915,932	20,493,641	89.4	2,422,291	10.6
Rents, taxes, insurance, and miscellaneous expenses	11,895,206	11,456,037	96.3	439,169	3.7
Interest on bonds	12,623,545	12,118,740	96.0	504,805	4.0

Table 15 shows the percentage that each of the main divisions of expense is of the total for all stations and for private and municipal stations, respectively.

TABLE 15.—*Percentage that each item of expense is of total—private and municipal stations: 1902.*

	Total.	Private stations.	Municipal stations.
Total	100.0	100.0	100.0
Salaries and wages	30.3	29.9	35.8
Cost of supplies, materials, and fuel	33.7	32.6	46.2
Rents, taxes, insurance, and miscellaneous expenses	17.5	18.2	8.4
Interest on bonds	18.5	19.3	9.6

The percentages shown in Table 15 vary greatly for private and municipal stations. In private stations the salaries and wages were 29.9 per cent, while in municipal stations they were 35.8 per cent of the total expense. In private stations the supplies, materials, and fuel were 32.6 per cent, and in municipal stations, 46.2 per cent. In private stations the rents, taxes, insurance, and miscellaneous expenses were 18.2 per cent, and in municipal stations 8.4 per cent. In private stations the interest on bonds was 19.3 per cent, while in municipal stations it was only 9.6 per cent.

It is highly probable that in many cases municipal stations failed to report closely rents, insurance, taxes, and other miscellaneous expenses, because they would be included in a general account for other public works, and it would be impossible to make an exact or equable division. The interest on bonds is relatively small, largely because many of the bonds issued to purchase or construct stations have been paid and retired.

Income and expenses of stations, classified according to population of places in which located.—It has already been explained that a large number of the central stations of the country are engaged in other business than merely that of electric lighting. As stated on page 5, the stations have been classified with regard to their specific work and also with regard to population of places in which located and capacity of plant. Tables 16 to 23 deal with various aspects of the income and expenses, as well as some general statistics, thus considered. Tables 16 and 17 present the income and expenses of purely electric and composite private stations, respectively, classified according to the population of the places in which located. Tables 18 and 19 show similar statistics for municipal stations. Tables 20 and 21 deal with income and expenses of private stations, classified according to the horsepower capacity of their dynamos, while Tables 22 and 23 give the two classes of municipal stations on the same basis.

TABLE 16.—INCOME AND EXPENSES—PURELY ELECTRIC PRIVATE STATIONS, CLASSIFIED ACCORDING TO POPULATION OF PLACES IN WHICH LOCATED: 1902.

	Total.	POPULATION OF PLACES IN WHICH LOCATED.				
		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.
Number of stations	1,759	1,345	277	76	44	17
Cost of construction and equipment	$320,580,333	$42,307,091	$45,951,671	$49,257,859	$98,259,566	$84,804,146
Gross income	$54,455,737	$9,654,207	$7,840,871	$8,521,413	$11,445,572	$16,993,674
Income from sale of current	$53,394,158	$9,413,217	$7,608,688	$8,208,964	$11,212,655	$16,950,634
Arc lighting	$14,721,531	$1,784,903	$1,870,485	$2,457,083	$3,502,671	$5,106,389
Incandescent lighting	$28,082,469	$6,512,620	$3,562,386	$4,013,412	$5,055,736	$8,938,315
All other electric service	$10,590,158	$1,115,694	$2,175,817	$1,738,469	$2,654,248	$2,905,930
Income from all other sources	$1,061,579	$240,990	$232,183	$312,449	$232,917	$43,040
Total expenses	$43,292,764	$7,411,951	$6,290,796	$6,223,741	$8,710,377	$14,655,899
Salaries and wages	$12,776,849	$2,696,664	$1,956,675	$1,800,245	$2,431,439	$3,891,826
Cost of supplies and materials	$5,625,812	$1,061,180	$682,743	$987,094	$952,611	$1,942,184
Cost of fuel	$6,652,316	$1,682,280	$1,003,960	$1,067,900	$1,289,682	$1,608,494
Rent of power	$1,416,858	$265,328	$302,910	$337,292	$504,128	$7,200
Rents, taxes, insurance, and miscellaneous	$8,053,677	$1,110,659	$1,060,194	$1,251,355	$1,654,526	$2,976,943
Interest on bonds	$8,767,252	$595,840	$1,284,314	$779,855	$1,877,991	$4,229,252
Salaried officials and clerks:						
Number	3,765	1,298	725	456	551	735
Salaries	$3,507,953	$829,383	$579,030	$503,165	$732,377	$863,998
Wage-earners:						
Average number	13,976	3,261	2,199	1,895	2,581	4,040
Wages	$9,268,896	$1,867,281	$1,377,645	$1,297,080	$1,699,062	$3,027,828

It will be seen from Table 16 that the 1,759 purely electric private stations represented a cost of construction and equipment of $320,580,333, and derived from the sale of current and all other sources a gross income of $54,455,737, against which there were expenses chargeable of $43,292,764. The items of income and expenses are shown in the table. These stations employed 3,765 officials drawing salaries of $3,507,953, and 13,976 wage-earners to whom were paid wages amounting to $9,268,896.

The grouping by population shows that the 61 stations in cities with a population of 100,000 and upward represented a cost of construction and equipment of $183,063,712, while the remaining 1,698 stations represented a cost of construction and equipment of only $137,516,621. By far the largest class is that associated with places of less than 5,000 inhabitants, there being 1,345 such stations. A somewhat significant fact as to the general contention that in the smaller communities it is advisable and desirous to consolidate enterprises in different fields of public service, so as to secure the highest economy and efficiency by concentration of effort, is that 1,345 stations, with a gross income of $9,654,207, required 1,298 officials drawing $829,383 in salaries, while the 17 stations in cities having a population of 500,000 and over, with a gross income of $16,993,674, found it necessary to employ only 735 salaried officials and clerks drawing $863,998; moreover, the 1,345 stations required 3,261 wage-earners, while the 17 stations, with earnings almost double, required only 4,040. The rate of wages paid, however, is much higher in the group reported for large cities, where the wages amounted to $3,027,828, while in the other case it was $1,867,281, the respective figures per capita per annum being about $749 and $572.

TABLE 17.—INCOME AND EXPENSES—COMPOSITE PRIVATE STATIONS, CLASSIFIED ACCORDING TO POPULATION OF PLACES IN WHICH LOCATED: 1902.

	Total.	POPULATION OF PLACES IN WHICH LOCATED.				
		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.
Number of stations	1,046	698	277	39	23	9
Cost of construction and equipment	$162,139,546	$18,411,443	$52,758,274	$19,515,289	$47,431,581	$24,022,959
Gross income	$24,279,763	$4,340,587	$7,317,687	$3,803,482	$5,537,380	$3,280,627
Income from sale of current	$23,955,591	$4,243,785	$7,170,897	$3,759,866	$5,504,800	$3,276,243
Arc lighting	$7,370,269	$878,602	$2,393,938	$1,333,139	$2,113,129	$651,461
Incandescent lighting	$13,215,015	$3,066,862	$3,779,997	$1,941,962	$2,387,984	$2,038,210
All other electric service	$3,370,307	$298,321	$996,962	$484,765	$1,003,687	$586,572
Income from all other sources	$324,172	$96,802	$146,790	$43,616	$32,580	$4,384
Total expenses	$19,542,624	$3,480,277	$6,033,609	$3,115,057	$4,530,913	$2,382,768
Salaries and wages	$5,990,121	$1,240,157	$1,908,627	$903,639	$1,218,690	$719,008
Cost of supplies and materials	$2,670,951	$484,494	$783,737	$379,882	$664,492	$358,346
Cost of fuel	$3,537,369	$821,534	$1,264,702	$446,241	$723,667	$281,225
Rent of power	$590,335	$171,752	$126,002	$155,062	$127,093	$10,426
Rents, taxes, insurance, and miscellaneous	$3,402,360	$500,629	$909,340	$516,806	$942,716	$532,869
Interest on bonds	$3,351,488	$261,711	$1,041,201	$713,427	$854,255	$480,894
Salaried officials and clerks:						
Number	2,281	634	862	258	252	275
Salaries	$1,698,246	$330,923	$553,260	$249,188	$285,911	$278,964
Wage-earners:						
Average number	6,887	1,687	2,231	954	1,405	610
Wages	$4,291,875	$909,234	$1,355,367	$654,451	$932,779	$440,044

Table 17 includes the statistics of 1,046 private stations operated in connection with other business. The cost of construction and equipment of these stations was $162,139,546, the gross income was $24,279,763, and the expenses were $19,542,624. These stations employed 2,281 salaried officials and clerks, who received $1,698,246 in salaries, and 6,887 wage-earners who were paid $4,291,875. Of these composite plants, only 32 were in cities of 100,000 or more inhabitants; only 39 were in cities of a population of between 25,000 and 100,000; 277 were in cities of between 5,000 and 25,000; and 698 were in communities of less than 5,000. The effect of operating more than one kind of business is shown chiefly in the group of 698 small stations, which employed 634 salaried officials and clerks, or less than 1 per station, a palpable indication of the division of executive labor and expense among different departments of the business. The salaries paid these officials amounted to $330,923, or about $522 each, this small average being a further indication of the fact that the income must be brought up to the normal amount for men in such positions by being derived in part from other sources. In the 9 stations of the largest composite class 275 officials were paid $278,964, or about $1,015 each, which reveals a sharper definition of function and with it a better rate of salary. The 698 small stations employed 1,687 wage-earners, or more than 2 per station, and paid in wages $909,234, or almost $539 per employee, while the 9 stations employed 610 men, an average of about 68 per station, and at a rate of slightly over $721 per employee.

It is chiefly in connection with the salaries and wages that the economies of the composite stations are to be looked for, although some advantage should appear in the items of fuel and rent. Earnings from the sale of current by the 1,759 exclusively electric stations were $53,394,158, with a bill for fuel and rented power of $8,069,174. The 1,046 composite stations, with earnings of $23,955,591 from the sale of current, incurred expenses

amounting to $4,127,704 for fuel and rent of power; thus the composite stations, with considerably less than half the earnings, required considerably more than half the amount of outlay for generating current. While this apparent absence of the looked for economy might be due to the lesser magnitude of the station—it being a general truth that the cost of producing power becomes higher as the station decreases in size—it is also possible that in the case of the stations operated in conjunction with other businesses some of the expenses for fuel and power charged against them should properly be debited to the associate industry.

While the private stations that are of a composite character are much fewer in number than the purely electric ones, the municipal stations that are operated in connection with other businesses are somewhat more numerous than those that are purely electric, as might have been expected from the fact that the first argument for the installation of a municipal electric lighting station is that it can be operated to great economical advantage in connection with some other city service, particularly waterworks or gas works.

TABLE 18.—INCOME AND EXPENSES—PURELY ELECTRIC MUNICIPAL STATIONS, CLASSIFIED ACCORDING TO POPULATION OF PLACES IN WHICH LOCATED: 1902.

	Total.	POPULATION OF PLACES IN WHICH LOCATED.				
		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.
Number of stations	380	288	73	10	6	3
Cost of construction and equipment	$13,571,391	$4,807,586	$3,843,182	$1,334,848	$1,607,803	$1,977,972
Gross income[1]	$4,147,669	$1,526,686	$1,146,261	$378,094	$441,235	$655,393
Income from sale of current[1]	$4,076,439	$1,488,099	$1,127,209	$378,039	$427,699	$655,393
Arc lighting	$2,276,193	$509,982	$602,458	$194,674	$319,186	$649,893
Incandescent lighting	$1,732,235	$959,421	$496,659	$171,228	$99,427	$5,500
All other electric service	$68,011	$18,696	$28,092	$12,137	$9,086	.....
Income from all other sources	$71,230	$38,587	$19,052	$55	$13,536	.....
Total expenses	$3,021,025	$1,238,988	$871,138	$297,720	$295,851	$317,328
Salaries and wages	$1,114,577	$425,356	$321,529	$100,560	$137,319	$129,813
Cost of supplies and materials	$464,938	$196,410	$140,391	$42,526	$38,553	$47,058
Cost of fuel	$781,558	$348,255	$217,534	$55,547	$57,301	$102,921
Rent of power	$104,796	$35,902	$29,902	$38,992	.....	.....
Rents, taxes, insurance, and miscellaneous	$281,197	$103,015	$83,648	$34,565	$22,433	$37,536
Interest on bonds	$273,959	$130,050	$78,134	$25,530	$40,245	.....
Salaried officials and clerks:						
Number	456	271	135	23	17	10
Salaries	$246,280	$119,096	$80,565	$18,818	$18,401	$9,400
Wage-earners:						
Average number	1,412	579	390	132	170	141
Wages	$868,297	$306,260	$240,964	$81,742	$118,918	$120,413

[1] Includes estimated income from public lighting.

TABLE 19.—INCOME AND EXPENSES—COMPOSITE MUNICIPAL STATIONS, CLASSIFIED ACCORDING TO POPULATION OF PLACES IN WHICH LOCATED: 1902.

	Total.	POPULATION OF PLACES IN WHICH LOCATED.				
		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.
Number of stations	435	383	48	3	.....	1
Cost of construction and equipment	$8,449,082	$6,266,422	$1,761,996	$219,083	.....	$201,581
Gross income[1]	$2,817,436	$2,094,337	$618,739	$77,110	.....	$27,250
Income from sale of current[1]	$2,760,417	$2,050,369	$605,688	$77,110	.....	$27,250
Arc lighting	$1,113,052	$657,479	$368,013	$66,310	.....	$21,250
Incandescent lighting	$1,627,383	$1,382,849	$227,734	$10,800	.....	$6,000
All other electric service	$19,982	$10,041	$9,941	.....	.....	.....
Income from all other sources	$57,019	$43,968	$13,051	.....	.....	.....
Total expenses	$2,224,962	$1,701,610	$452,810	$50,236	.....	$26,306
Salaries and wages	$765,145	$560,894	$175,529	$20,202	.....	$8,520
Cost of supplies and materials	$387,963	$281,660	$96,307	$8,815	.....	$1,181
Cost of fuel	$664,266	$540,168	$111,771	$10,312	.....	$2,015
Rent of power	$18,770	$9,064	$1,206	.....	.....	$8,500
Rents, taxes, insurance, and miscellaneous	$157,972	$119,443	$34,819	$3,620	.....	$90
Interest on bonds	$230,846	$190,381	$33,178	$7,287	.....	.....
Salaried officials and clerks:						
Number	494	419	72	1	.....	2
Salaries	$211,101	$175,193	$33,088	$300	.....	$2,520
Wage-earners:						
Average number	1,055	780	240	27	.....	8
Wages	$554,044	$385,701	$142,441	$19,902	.....	$6,000

[1] Includes estimated income from public lighting.

Of the 815 municipal stations included in Tables 18 and 19, 435 are shown to be composite in character and 380 purely electric. As with the private stations, the purely electric plants represent a larger cost of construction and equipment, the amount being $13,571,391, with a gross income of $4,147,669 and expenses of $3,021,025. The 435 composite plants represent a cost of construction and equipment of $8,449,082, with a gross income from all sources of $2,817,436 and expenses of $2,224,962. The 456 salaried officials in the

purely electric stations were paid $246,280, while the 494 in the composite group were paid $211,101, the rates being $540 and $427, respectively. In both cases these rates fall below the corresponding rates for private stations, but it should be borne in mind that while the station may be exclusively electric the salaried officials may be engaged on some other municipal work from which they derive an income. In the composite stations, especially, the salaries are apt to be made up from other sources. Here, again, there is danger of drawing wrong inferences from the figures, as shown by the fact that in the three composite stations with a generating capacity of 500 to 1,000 horsepower, there was an average of only one salaried employee per station and he received only $366 a year, although the stations represented a cost of construction and equipment of $288,913 and had an income of $77,154, with expenses of $44,875. It stands to reason that both the number of salaried officials and the amount of salaries are subject to a finer analysis on account of the unequal distribution or allocation in connection with the other businesses, although the Bureau of the Census in every case did its best to secure a proper division of items bearing upon the subject, and the figures cited are doubtless those upon which the local lighting budgets were made up.

Income and expenses of stations, classified according to dynamo capacity.—Tables 20 and 21 indicate in a general way the greater magnitude of the purely electric private stations, as compared with the composite stations.

TABLE 20.—INCOME AND EXPENSES—PURELY ELECTRIC PRIVATE STATIONS, CLASSIFIED ACCORDING TO HORSEPOWER CAPACITY OF DYNAMOS: 1902.

	Total.	HORSEPOWER CAPACITY OF DYNAMOS.					
		Under 200.	200 but under 500.	500 but under 1,000.	1,000 but under 2,000.	2,000 but under 5,000.	5,000 and over.
Number of stations	1,759	1,026	445	121	78	56	33
Cost of construction and equipment	$320,580,333	$16,424,851	$21,754,260	$16,190,380	$25,575,349	$50,117,445	$190,518,048
Gross income	$54,455,737	$4,999,517	$5,582,411	$3,585,065	$5,102,347	$8,639,398	$26,546,999
Income from sale of current	$53,394,158	$4,852,472	$5,393,390	$3,518,423	$4,937,700	$8,406,143	$26,286,030
Arc lighting	$14,721,531	$1,036,360	$1,371,498	$988,447	$1,563,861	$2,507,585	$7,253,780
Incandescent lighting	$28,082,469	$3,711,212	$3,688,358	$1,988,136	$2,378,876	$3,617,887	$12,698,000
All other electric service	$10,590,158	$104,900	$333,534	$541,840	$994,963	$2,280,671	$6,334,250
Income from all other sources	$1,061,579	$147,045	$189,021	$66,642	$164,647	$233,255	$260,969
Total expenses	$43,292,764	$3,792,323	$4,348,944	$2,860,230	$3,804,941	$6,298,486	$22,187,840
Salaries and wages	$12,776,849	$1,389,779	$1,570,850	$924,202	$1,202,748	$1,838,489	$5,850,781
Cost of supplies and materials	$5,625,812	$591,534	$692,939	$390,812	$482,416	$823,049	$2,645,062
Cost of fuel	$6,652,316	$965,778	$937,729	$583,165	$738,811	$999,111	$2,427,722
Rent of power	$1,416,858	$209,879	$179,182	$160,219	$159,486	$327,092	$381,000
Rents, taxes, insurance, and miscellaneous	$8,053,677	$539,403	$660,356	$529,568	$733,941	$1,326,627	$4,263,782
Interest on bonds	$8,767,252	$95,950	$307,888	$272,264	$487,539	$984,118	$6,619,493
Salaried officials and clerks:							
Number	3,765	743	757	348	346	410	1,161
Salaries	$3,507,953	$395,123	$495,244	$269,799	$356,122	$540,081	$1,451,584
Wage-earners:							
Average number	13,976	1,901	1,818	1,005	1,268	2,026	5,958
Wages	$9,268,896	$994,656	$1,075,606	$654,403	$846,626	$1,298,408	$4,399,197

TABLE 21.—INCOME AND EXPENSES—COMPOSITE PRIVATE STATIONS, CLASSIFIED ACCORDING TO HORSEPOWER CAPACITY OF DYNAMOS: 1902.

	Total.	HORSEPOWER CAPACITY OF DYNAMOS.					
		Under 200.	200 but under 500.	500 but under 1,000.	1,000 but under 2,000.	2,000 but under 5,000.	5,000 and over.
Number of stations	1,046	624	255	80	48	25	14
Cost of construction and equipment	$162,139,546	$10,157,397	$15,809,884	$14,701,895	$17,727,955	$32,066,942	$71,675,473
Gross income	$24,279,763	$2,925,026	$3,869,430	$2,653,918	$3,353,809	$2,763,537	$8,714,043
Income from sale of current	$23,955,591	$2,873,331	$3,780,444	$2,609,778	$3,304,841	$2,707,360	$8,679,837
Arc lighting	$7,370,269	$672,777	$1,163,709	$850,469	$1,158,251	$848,667	$2,676,396
Incandescent lighting	$13,215,015	$2,105,263	$2,345,172	$1,397,354	$1,670,560	$1,305,166	$4,391,500
All other electric service	$3,370,307	$95,291	$271,563	$361,955	$476,030	$553,527	$1,611,941
Income from all other sources	$324,172	$51,695	$88,986	$44,140	$48,968	$56,177	$34,206
Total expenses	$19,542,624	$2,388,966	$3,096,647	$2,154,597	$2,619,635	$2,424,918	$6,857,861
Salaries and wages	$5,990,121	$870,767	$1,075,553	$677,097	$806,551	$704,567	$1,855,586
Cost of supplies and materials	$2,670,951	$343,951	$437,115	$296,378	$321,402	$222,094	$1,050,011
Cost of fuel	$3,537,369	$633,227	$643,379	$488,191	$517,248	$390,090	$865,234
Rent of power	$590,335	$93,783	$141,725	$35,691	$125,864	$35,880	$157,392
Rents, taxes, insurance, and miscellaneous	$3,402,360	$316,815	$442,383	$327,521	$457,162	$422,573	$1,435,906
Interest on bonds	$3,351,488	$130,423	$356,492	$329,719	$391,408	$649,714	$1,493,732
Salaried officials and clerks:							
Number	2,281	494	535	259	266	221	506
Salaries	$1,698,246	$234,499	$309,470	$182,287	$225,227	$174,789	$571,974
Wage-earners:							
Average number	6,887	1,265	1,316	771	864	803	1,868
Wages	$4,291,875	$636,268	$766,083	$494,810	$581,324	$529,778	$1,283,612

It will be seen from the groups made on the basis of dynamo capacity that 33 purely electric private stations had dynamos of a capacity of over 5,000 horsepower; 56, of between 2,000 and 5,000 horsepower; 78, of between 1,000 and 2,000 horsepower; 121, of between 500 and 1,000 horsepower; 445, of between 200 and 500 horsepower; and 1,026, of less than 200 horsepower. On the other hand, as shown by Table 21, the composite stations included but 14 stations with a dynamo capacity of 5,000 horsepower and upward; 25, of between 2,000 and 5,000 horsepower; 48, of between 1,000 and 2,000 horsepower; 80, of between 500 and 1,000 horsepower; 255, of between 200 and 500 horsepower; and 624, of less than 200 horsepower.

Tables 22 and 23 present a classification of municipal stations, both purely electric and composite, on the basis of the horsepower capacity of their dynamos.

TABLE 22.—INCOME AND EXPENSES—PURELY ELECTRIC MUNICIPAL STATIONS, CLASSIFIED ACCORDING TO HORSEPOWER CAPACITY OF DYNAMOS: 1902.

	Total.	HORSEPOWER CAPACITY OF DYNAMOS.					
		Under 200.	200 but under 500.	500 but under 1,000.	1,000 but under 2,000.	2,000 but under 5,000.	5,000 and over.
Number of stations	380	269	78	22	8	2	1
Cost of construction and equipment	$13,571,391	$3,989,635	$3,092,468	$2,200,337	$1,769,367	$1,103,232	$1,416,352
Gross income[1]	$4,147,669	$1,340,157	$925,393	$595,141	$554,156	$228,389	$504,433
Income from sale of current[1]	$4,076,439	$1,315,548	$908,767	$578,900	$553,938	$214,853	$504,433
Arc lighting	$2,276,193	$539,058	$502,879	$223,020	$321,014	$186,289	$503,933
Incandescent lighting	$1,732,235	$759,744	$394,439	$324,674	$224,450	$28,428	$500
All other electric service	$68,011	$16,746	$11,449	$31,206	$8,474	$136	.....
Income from all other sources	$71,230	$24,609	$16,626	$16,241	$218	$13,536	.....
Total expenses	$3,021,025	$1,085,266	$743,571	$483,766	$311,128	$149,190	$248,104
Salaries and wages	$1,114,577	$388,118	$274,164	$155,305	$129,557	$71,164	$96,269
Cost of supplies and materials	$464,938	$168,282	$114,211	$80,763	$44,878	$18,283	$38,521
Cost of fuel	$781,558	$305,611	$188,485	$86,100	$93,920	$28,453	$78,989
Rent of power	$104,796	$31,839	$23,823	$49,134	.....	.....	.....
Rents, taxes, insurance, and miscellaneous	$281,197	$86,693	$67,945	$55,921	$31,023	$5,290	$34,325
Interest on bonds	$273,959	$104,723	$74,943	$56,543	$11,750	$26,000	.....
Salaried officials and clerks:							
Number	456	235	118	60	24	13	6
Salaries	$246,280	$107,113	$65,609	$37,396	$19,806	$12,106	$4,250
Wage-earners:							
Average number	1,412	526	340	177	167	96	106
Wages	$868,297	$281,005	$208,555	$117,909	$109,751	$59,058	$92,019

[1] Includes estimated income from public lighting.

TABLE 23.—INCOME AND EXPENSES—COMPOSITE MUNICIPAL STATIONS, CLASSIFIED ACCORDING TO HORSEPOWER CAPACITY OF DYNAMOS: 1902.

	Total.	HORSEPOWER CAPACITY OF DYNAMOS.					
		Under 200.	200 but under 500.	500 but under 1,000.	1,000 but under 2,000.	2,000 but under 5,000.	5,000 and over.
Number of stations	435	343	86	3	3	.....	.....
Cost of construction and equipment	$8,449,082	$4,816,612	$3,122,060	$288,913	$221,497	.....	.....
Gross income[1]	$2,817,436	$1,679,501	$959,479	$77,154	$101,302	.....	.....
Income from sale of current[1]	$2,760,417	$1,652,068	$930,950	$77,154	$100,245	.....	.....
Arc lighting	$1,113,052	$639,914	$399,631	$46,286	$27,221	.....	.....
Incandescent lighting	$1,627,383	$1,004,832	$524,449	$30,568	$67,534	.....	.....
All other electric service	$19,982	$7,322	$6,870	$300	$5,490	.....	.....
Income from all other sources	$57,019	$27,433	$28,529	.....	$1,057	.....	.....
Total expenses	$2,224,962	$1,345,138	$743,060	$44,875	$91,889	.....	.....
Salaries and wages	$765,145	$459,848	$257,010	$18,828	$29,459	.....	.....
Cost of supplies and materials	$387,963	$218,057	$138,984	$7,923	$22,999	.....	.....
Cost of fuel	$664,266	$421,832	$215,326	$10,411	$16,697	.....	.....
Rent of power	$18,770	$10,270	$8,500	.....	.....	.....	.....
Rents, taxes, insurance, and miscellaneous	$157,972	$93,355	$50,592	$4,338	$9,687	.....	.....
Interest on bonds	$230,846	$141,776	$72,648	$3,375	$13,047	.....	.....
Salaried officials and clerks:							
Number	494	358	126	3	7	.....	.....
Salaries	$211,101	$134,993	$70,032	$1,100	$4,976	.....	.....
Wage-earners:							
Average number	1,055	665	328	28	34	.....	.....
Wages	$554,044	$324,855	$186,978	$17,728	$24,483	.....	.....

[1] Includes estimated income from public lighting.

These figures do not call for extensive comment, but it might be pointed out that only 6 of the composite stations had dynamos with a capacity of 500 or more horsepower and 343 out of 435 had less than 200 horsepower. Both the cost of construction and equipment and the size of the plant were greater for the purely electric class. It is observed that the 11 stations with a dynamo capacity of 1,000 horsepower or more represented a much heavier cost of construction than all of the 269 under 200 horsepower. The 11 stations involved an outlay of $4,288,951, while the 269 were reported as having expended $3,989,635. It may be noted, on the other hand, that the earnings from the sale of current of the 269 stations with the smaller cost of equipment were $1,315,548, while the earnings from the sale of current of the 11 large stations with the larger cost were only $1,273,224.

As in the case of private stations, the assumption that there is a saving of expenses as a result of the operation of various enterprises from one station is hardly substantiated by the statistics. The strictly electric municipal stations reported earnings of $4,076,439 from the sale of current, at a cost of $886,354 for fuel and power. The composite stations reported earnings of $2,760,417 from the sale of current, requiring an expenditure of $683,036 for fuel and rented power. The lesser magnitude of the private stations operated in connection with other business would prevent them from showing up well in comparison with the larger purely electric stations. Moreover, it may be assumed that in many instances, in spite of surface indications, there is a real economy or benefit resulting from the combination of various businesses in this manner, and that without such a division of executive and physical expenses the advantages of electric light and power would probably be beyond the reach of many of the smaller communities.

IV.

INCOME.

General analysis of income.—In the section immediately preceding, reference has been made to the general statistics of income in private and municipal central stations, and the totals were summarized in Tables 12 and 13. As is well known, the two main departments of business in the industry are arc lighting and incandescent lighting. The receipts from both of these are clearly set forth in the returns, and the remainder of the income is grouped into two other classes, namely, "all other electric service," and "all other sources." By far the most important item of the income from "all other electric service" is that derived from the sale of current for the operation of stationary and railway motors. Where current is sold by meter, however, it is practically impossible to state the exact amount received from this branch of the service, while it is not at all improbable that a distinct percentage of the income returned as from incandescent lighting might be attributed to motor earnings. The motors are to-day almost invariably operated on the incandescent circuits, and a central station, without a very close census of its customers, is not able to tell to what extent its circuits are drawn upon for motors unless the motors have been installed under some special arrangement or take current in notably large quantities. A consideration of this question will be given more in detail in connection with the closer analysis of the income arrived at in other tables.

As shown in Tables 12 and 13, of the $85,700,605 received as income, arc lighting supplied $25,481,045; incandescent lighting, $44,657,102; all other electric service, $14,048,458; and all other sources, $1,514,000. These four classes formed the following proportions of the total: Arc lighting, 29.7 per cent; incandescent lighting, 52.1 per cent; all other electric service, 16.4 per cent; and all other sources, 1.8 per cent. The income is almost entirely derived from the sale of current to be converted either into illumination or into motive power.

Income of private stations, by states.—The gross income of the private stations, as shown in Table 68, was $78,735,500, of which $77,349,749 was from sale of current and $1,385,751 from all other sources. The earnings from the sale of current were divided as follows: Arc lighting, $22,091,800; incandescent lighting, $41,297,484; and all other electric service, $13,960,465. By far the largest earnings were reported from the state of New York, where the gross income was $16,631,802, of which all but $112,313 was derived from the sale of current. The next largest earnings were those of Pennsylvania, for which state the gross income was $9,057,503, of which all but $172,440 was derived from the sale of current. Third in order was Massachusetts, with a gross income of $6,070,643, of which all but $90,683 resulted from the sale of current. Fourth in magnitude was Illinois, with $5,578,012, of which all but $63,443 was from the sale of current. Closely following Illinois was California, with the large income of $4,937,444, of which all but $113,405 was from the sale of current.

For the 5 states named above the reports showed a gross income of $42,275,404, or nearly one-half of the total for the country. For the next most important group of 5 states, namely, Ohio, New Jersey, Missouri, Texas, and Michigan, the reports showed a gross income of $13,042,876. Thus for these 10 states the gross income amounted to $55,318,280, or about 70.2 per cent of the total for all private stations. A large amount of income was not reported for any of the Southern states except Missouri and Texas. The gross income for Missouri was brought up by the heavy earnings of St. Louis, while Texas, with $1,957,568, is a magnificent exception to the low average of the South-

ern states. The most noteworthy instance of income from central station operation is found in the state of Montana, which, with a population of 243,329, had an income of more than a million dollars. When this income is compared with those of the more populous states, the high ratio for this state is surprising.

The figures in Table 68 should not, however, be taken as representing the absolute total for each state in the field of electric lighting, as in many instances central stations were operated in conjunction with electric railway systems. There were 253 electric railway companies that reported income from the sale of current for electric lighting and power purposes. Of these, 118 made supplementary reports, which showed receipts of $6,469,726 from the lighting and power part of the business. It is obvious that the distribution of this amount among the central stations in the various states would be likely in several of them to increase quite noticeably the income derived from the electric lighting and power industry. In this connection attention is again called to Table 97, which shows the income of these stations by states.

Income of municipal stations, by states.—An analysis of the income of municipal stations, by states, is given in Table 78. The gross income for the United States was $6,965,105, of which all but $128,249 was derived from the sale of current. This gross income was earned by 815 stations, giving an annual income per station of $8,546 per year, as compared with an average of $28,070 for private stations. The state with the largest amount was Illinois, the sum being $1,179,003. This represents an average of $14,378 for the 82 stations, but the fact is that this average is brought up almost entirely by the large municipal system in Chicago. Illinois did not represent the highest average per station, the figures of that state being exceeded in several others. In Connecticut the 3 stations reported an income that averaged over $15,000 per station; the 17 stations in Massachusetts had an average of $15,900; the 1 station in Montana, $16,208; the 7 stations in Texas, nearly $17,000; the 7 stations in Washington, over $21,000; and the 5 stations in Florida, over $26,000. On the other hand, the states in which the income per station fell below the average for the United States were numerous. In Colorado the 2 municipal stations reported an average of only $2,763 per station; the single station in Utah, only $2,870; the single station in New Hampshire, $3,250; the 6 stations in Oregon, slightly more than $3,500; the 19 stations in Tennessee, $4,436; and the 16 stations in North Carolina, less than $6,000. In Vermont 11 stations reported a gross income of $52,113, or considerably less than $5,000 per station, while the 10 in Virginia reported $55,826, or slightly more than $5,500 per station. Such figures are significantly indicative of the smallness of the communities served.

Income from lighting.—According to Tables 76 and 86, which will be discussed later, the income from the sale of current for lighting purposes was derived from 385,698 arc lamps and 18,194,044 incandescent lamps. The following statement shows the number of arc and incandescent lamps reported by private and municipal stations, as used for commercial and public service, as well as the total income from each variety of lamp with the average income per lamp:

Number of lamps in service, total income, and average income per lamp: 1902.

	ARC LAMPS.		INCANDESCENT LAMPS.	
	Commercial or other private service.	Public service.	Commercial or other private service.	Public service.
Private stations:				
Number of lamps	168,180	166,723	16,243,853	372,740
Total income	$8,220,154	$13,871,646	$39,039,557	$2,257,927
Average income per lamp	$48.88	$83.20	$2.40	$6.06
Municipal stations:				
Number of lamps	5,793	45,002	1,494,531	82,920
Total income	$240,166	[1] $3,149,079	$2,868,296	[1] $491,322
Average income per lamp	$41.46	$69.98	$1.92	$5.93

[1] Value estimated according to prevailing rates.

While it must be borne in mind that in many cases the number of lamps reported was estimated, it is believed that the totals approximate sufficiently the actual numbers not to vitiate seriously the deductions arrived at from the above statement and from other tables that follow.

Of the 334,903 arc lamps reported by all stations operating under private ownership, 168,180, or 50.2 per cent, were used for commercial or other private lighting, and furnished an income of $8,220,154, or $48.88 per lamp; and 166,723, or 49.8 per cent, were used for public lighting, and furnished an income of $13,871,646, or $83.20 per lamp. Of the 50,795 lamps reported by municipal stations, 5,793 were used in commercial or other private lighting, and furnished an income of $240,166, or $41.46 per lamp; and 45,002, or 88.6 per cent, were used for public lighting, and had an estimated income of $3,149,079, or $69.98 per lamp.

As already stated, the income of municipal stations from public lighting can not be arrived at directly, as there is generally no basis, scale, or rate of charges by the community to itself, and the income from public lighting is therefore estimated for each station at the commercial rates prevailing in the vicinity or region. The number of lamps, however, is not the number actually rendering service at any one time, but only the number in position to render service and therefore to earn an income.

Of the incandescent lamps, 16,243,853 were in commercial use from private stations and earned $39,039,557, or an average income of $2.40 per lamp; and 1,494,531 were in commercial service from municipal stations

and earned $2,868,296, or $1.92 per lamp. In public service there were 372,740 incandescent lamps from private stations and these lamps earned $2,257,927, or an average income of $6.06 per lamp; and 82,920 were in public service from municipal stations and earned $491,322, or an average per lamp of $5.93. Incidentally it may be pointed out that the incandescent lamps in private service were usually of 16 candlepower, while those in public service were often of 32 and 50 candlepower, and were burned more continuously.

Basis of income from arc lamps.—While the average earnings of the arc lamps were $66.06, the amount per lamp ran through a wide range. Although round figures are very often quoted in comparing the rates in one city with those in another, regardless of the underlying conditions, the prices actually paid for arc lamps vary with almost every station. The price of supplying an arc lamp is determined by a number of conditions, such as the variation in the cost of waterpower and steampower, the use of overhead wires or underground circuits, the employment of large arcs requiring 550 watts at the lamp terminals or smaller arcs requiring only 340 or 350 watts, the use of open or inclosed lamps, the local prices of labor, the cost of land, and the rate of taxes. Aside from these variable elements are those attaching to the length of term of contract made. An electric lighting company invariably makes a considerable reduction when enabled by a long contract to invest safely in the necessary machinery.

As a matter of fact the companies are very often under pressure or inducements that result in rates below a profitable point, and will quote low figures to secure a franchise and even lower ones to keep a competitor out, or to prevent the installation of a municipal system. Superficially, the public benefits, but it may be questioned whether rates thus unduly depressed can make for good and efficient service.

Another fluctuating element is the number of hours of burning. In 1902 there were in the United States some seven main schedules with regard to the time of burning, and in the schedules there was a possible range of at least one hundred and fifty changes. These schedules comprised, for example, various forms of midnight moonlight schedules, ranging ordinarily from 1,220 to 1,387 hours per year, with actual variations from 1,053 to 1,485 hours. There are also a standard 1 a. m. moonlight schedule, a 2 a. m. moonlight schedule, a midnight every night schedule, a 12.30 a. m. every night schedule, a 1 a. m. every night schedule, a moonlight and cloudy night schedule, a 3 a. m. every night schedule, a standard Philadelphia schedule of 10 hours nightly, and a standard all night every night schedule of 4,000 hours.

The rate in the borough of Manhattan for all night lights with underground circuits, but only on a year-to-year contract, was $146 a year. In Boston, where the arc lighting contract is on a basis of five-year periods, the price was $124.10. In Philadelphia, where the contract embraced nearly 10,000 lights, as compared with less than 3,000 in New York, the price was $110.12. In Providence the rate was $118.62; in Cleveland, with overhead circuits, it fell to $77.88; in San Francisco it was $110. Practically all of these rates were on the all night every night basis for full arc lamps.

At Athens, Ga., the price per lamp was as low as $43.50, but this was only for 2,900 hours of burning, with all overhead circuits. At Canton, Ill., it was $48, but the lamps were what is known as "half arcs," and the period of burning was only 2,255 hours. At Elmwood, Ill., the rate was $48 for full arcs, but the period of burning was only 1,410 hours. At South Bend, Ind., full arcs burned for 1,825 hours were paid for at the rate of $62.50, but those burned for 4,000 hours cost $90. At Rockland, Me., on the other hand, the price for half arcs burned only 2,816 hours was $100 a year, while at Muscatine, Iowa, the rate for full arcs burned 4,000 hours rose to $132. It should not be overlooked, however, that at Rockland the price of steam coal was $5.52 per ton, although the high rate at Muscatine can not be accounted for in the same manner. At Haverhill, Mass., a city of less than 40,000 inhabitants, the rates were also high, being $112 a year for lamps burned 3,122 hours, and $125 for lamps burned 3,768 hours.

While similar figures could be quoted from many schedules of other towns and cities, those already given will serve to illustrate the difficulty connected with the enumeration of arc lighting prices and with the determination as to how far they correspond in the matter of amount of service rendered. Superficially, the candlepower hours furnished for 1 cent ranged from about 300 up to 1,300, and in some cases even to 1,600; but special conditions would be found to affect the extreme cases and to explain the figures of marked cheapness or unusual dearness.

For fuller information on this subject the reader is referred to the statistics published yearly by the National Electric Light Association, embodying the conditions of municipal lighting contracts. The association publishes also rates for lighting and power service in commercial business, and here, again, endless variety exists, the prices paid being subject to rebates and conditions which make it almost impossible to determine how much each lamp has earned during the year. The charges for commercial arcs are usually on a basis of service from sunset until 9 o'clock, 10 o'clock, 11 o'clock, or midnight, with longer burning frequently for Saturday nights, and no burning for Sundays. The price for such service ranges from $1.25 to $2.25 per week. Sometimes, however, the current is sold on a monthly basis, say $6 or $7.50 per month, and in other instances it is sold at some such rate as 10 cents per hour for the

first 30 hours of maximum demand and 5 cents for all excess consumption, with a minimum charge of $2 a month per lamp. In still other instances, the rate is $5 per month in summer and $9 per month in winter on a midnight schedule. In almost every town and city each company has its own basis of charge and discount, a rebate being allowed for hours when the lamps are actually interrupted, and the discounts ranging from 10 to 20 per cent, according to the amount of the bills. Hence, even when the number of watt hours furnished to the lamps for 1 cent is figured out, a fair and safe comparison can not be reached until all the other elements are taken into consideration. Thus, while the figures cited here with regard to the average income of arc lamps are of interest, they should be regarded only as average, as the actual prices paid for street lighting would be found on examination to go far above the average of $83.20 per lamp quoted above, so far as the largest cities of the country are concerned, and to fall considerably below it in many of the smaller communities.

Basis of income from incandescent lamps.—The incandescent lamps also are subject to an infinite variety of rates, almost every city and town having its own scale of prices, some on a meter basis and some on a flat rate basis. It is quite customary to assume for rough and ready purposes of calculation an earning capacity of 1 cent per hour per incandescent lamp; but this, while a very fair approximation to the facts of the case, is subject to infinite variations. Where flat rates are applied, it is not at all unusual to find 16-candlepower lamps rated at a charge of 50 cents per month for use until 9 or 10 o'clock p. m. and 75 cents a month for all night use. In many instances current for such lamps when metered is sold at a rate of from 10 cents to 15 or 20 cents per kilowatt hour, and is subject to discounts which run as high as 50 per cent after a monthly consumption of 30 hours has been reached. Thus in Boston a demand system has been in use based upon 1 cent per 16-candlepower lamp per hour for the first 400 hours of use. When the use exceeds 400 hours a rebate of 40 per cent is given. Other demand systems have also been in use, in which the underlying aim has been to encourage large consumption or to make it inviting for a small consumer to use his maximum capacity by scaling down the prices after a lower limit has been reached, the fixed minimum being one that will to some extent recoup the lighting company for its fixed charges and its stand-by investment; that is, for the equipment which it must have ready in order to give service, so that it is competent to deal with any demand that may come upon the system. In many places residence lighting is fostered with discounts on a sliding scale from 20 per cent on bills under $2.50 per month up to 50 per cent on bills over $75 per month. A great many stations have also adopted a practice of making free lamp renewals; that is, they remove the old incandescent lamps and replace them with new ones upon the request of the consumer. In some cities a different rate is given in summer from that in winter. In Denver an interesting system has been in use for some time which assumes a fixed charge per customer to begin with. Thus the scale for incandescent lighting there has been $12 per year per consumer, plus $1.80 per year per lamp connected, plus 5 cents per kilowatt hour for current used. This is subject to a 10 per cent discount for prompt payment of monthly bills, and can be varied by a rate of 10 cents per kilowatt hour for metered current, with a minimum rental of $1.50 per month and at least 5 cents per lamp connected.

Income per lamp of stations, classified according to dynamo capacity.—In Tables 24 to 27 the gross figures of income from arc and incandescent lighting, the number of lamps, and the income per lamp are shown for stations classified according to the horsepower capacity of dynamos. Tables 24 and 25 present the statistics for purely electric and composite private stations, while Tables 26 and 27 show similar statistics for purely electric and composite municipal stations. In discussing these tables, attention is again called to the fact that in some cases the number of lamps was estimated, and, further, that in some instances income that properly belonged to motor service was credited to lighting.

The following table gives the statistics for the purely electric private stations:

TABLE 24.—INCOME PER LAMP—PURELY ELECTRIC PRIVATE STATIONS, CLASSIFIED ACCORDING TO HORSEPOWER CAPACITY OF DYNAMOS: 1902.

HORSEPOWER CAPACITY OF DYNAMOS.	ARC LIGHTING.								
	Total.			Commercial or other private.			Public.		
	Income.	Number of lamps.	Income per lamp.	Income.	Number of lamps.	Income per lamp.	Income.	Number of lamps.	Income per lamp.
Total	$14,721,531	219,409	$67.10	$5,365,793	107,743	$49.80	$9,355,738	111,666	$83.78
Under 200	1,036,360	16,660	62.21	248,062	4,664	53.19	788,298	11,996	65.71
200 but under 500	1,371,498	22,096	62.07	400,941	8,044	49.84	970,557	14,052	69.07
500 but under 1,000	988,447	16,146	61.22	301,796	6,845	44.09	686,651	9,301	73.83
1,000 but under 2,000	1,563,861	26,480	59.06	638,111	13,599	46.92	925,750	12,881	71.87
2,000 but under 5,000	2,507,585	39,048	64.22	861,046	19,821	43.44	1,646,539	19,227	85.64
5,000 and over	7,253,780	98,979	73.29	2,915,837	54,770	53.24	4,337,943	44,209	98.12

TABLE 24.—INCOME PER LAMP—PURELY ELECTRIC PRIVATE STATIONS, CLASSIFIED ACCORDING TO HORSEPOWER CAPACITY OF DYNAMOS: 1902—Continued.

HORSEPOWER CAPACITY OF DYNAMOS.	INCANDESCENT LIGHTING.								
	Total.			Commercial or other private.			Public.		
	Income.	Number of lamps.	Income per lamp.	Income.	Number of lamps.	Income per lamp.	Income.	Number of lamps.	Income per lamp.
Total	$28,082,469	11,463,050	$2.45	$26,591,126	11,195,351	$2.38	$1,491,343	267,699	$5.57
Under 200	3,711,212	1,259,022	2.95	3,304,222	1,212,655	2.72	406,990	46,367	8.78
200 but under 500	3,688,358	1,492,466	2.47	3,349,070	1,451,744	2.31	339,288	40,722	8.33
500 but under 1,000	1,988,136	801,130	2.48	1,827,663	779,914	2.34	160,473	21,216	7.56
1,000 but under 2,000	2,378,876	1,001,977	2.37	2,229,011	985,077	2.26	149,865	16,900	8.87
2,000 but under 5,000	3,617,887	1,300,055	2.78	3,525,092	1,282,659	2.75	92,795	17,396	5.33
5,000 and over	12,698,000	5,608,400	2.26	12,356,068	5,483,302	2.25	341,932	125,098	2.73

The number of arc lamps for which power was generated in the purely electric private stations was 219,409, and the earnings were $14,721,531, or $67.10 per lamp. Of the lamps, 107,743 were commercial or other private types, earning $5,365,793, or $49.80 per lamp, and 111,666 were public lamps, with an income of $9,355,738, or $83.78 per lamp.

The income per lamp does not appear to have been in proportion to the size of the plant, but was subject to many variations. The income per lamp in the commercial field, for example, was high in the two extreme classes, and in them was almost identical, being $53.19 for lamps operated from stations of less than 200 horsepower and $53.24 for lamps from stations of 5,000 horsepower and over. On the other hand, the revenue derived from public lighting was lowest in the class of stations of less than 200 horsepower and highest in the two groups with the larger plants. Thus for the smallest stations it was only $65.71 per lamp, while for the group with a horsepower capacity between 2,000 and 5,000 and that with a capacity of 5,000 or more it reached $85.64 and $98.12, respectively. The reason for this would appear to be that in the smaller stations the circuits are largely overhead, and, with other expenses on a lower plane, lamps and currents can be supplied at a cheaper rate, whereas the larger stations, as a rule, operate with underground circuits and are under heavier expense for rent, wages, etc. Moreover, the small stations showed a rather high return from commercial arc lighting as compared with almost all of the larger stations because very often the small plant is equipped for an arc lighting service only, and the customers have to take that or none at all, while in systems where the incandescent lamp is available it is preferred, since it is more suitable for many classes of service, and its use in corresponding degree lessens the returns from arc lighting. It is worthy of note that in purely electric stations of between 2,000 and 5,000 horsepower the income derived from commercial arc lamps was only $43.44 per lamp, or barely over half that derived from the longer burning public lamps, namely, $85.64, a ratio which is apparent also in the incandescent lighting.

In purely electric private stations, there were 11,195,351 incandescent lamps in commercial or other private service, with earnings of $26,591,126, or $2.38 per lamp; and 267,699 public incandescent lamps, with earnings of $1,491,343, or $5.57 per lamp. The reasons for this difference between commercial and public incandescent lighting have already been stated. The classification on the basis of capacity of plants brings out quite clearly the general tendency of the smaller plants to charge higher rates for incandescent service, the standard being 1 cent per 16-candlepower hour, while with the larger plants and the heavier production of current on a meter basis, lower rates are rendered more and more feasible. It will be seen that for stations of less than 200 horsepower, with a little over 10 per cent of the commercial lamps, the income per lamp was $2.72, which was higher than that for any class except that between 2,000 and 5,000 horsepower, in which the earnings were 3 cents more per lamp. The lamps operated from stations of 5,000 horsepower capacity and upward numbered 5,483,302, or not quite 50 per cent of the total, and the average yield for them was the lowest in the scale, being $2.25 per lamp.

In regard to incandescent public lighting the variations are apparently quite radical, but can be satisfactorily accounted for. In stations of less than 200 horsepower the income per public lamp was $8.78, this being exceeded only by that for lamps in stations of from 1,000 to 2,000 horsepower, where earnings were $8.87 per lamp. In the two classes comprising stations of the largest dynamo capacity the income per public lamp fell below the averages for the other classes; in the largest stations it was only $2.73 per lamp, or little more than the earnings per commercial lamp, namely, $2.25. As a matter of fact, in the large cities incandescent lamps, whether large or small, are seldom used for public or street lighting, so that the ordinary 16-candlepower lamps employed for public purposes would be likely to be subject to the ordinary hours of burning, except in such places as police stations, hospitals, and fire engine houses, where the average would be raised somewhat. In smaller communities, however, it is not an unusual thing to see street lighting attempted with

incandescent lamps, and these are usually supplied on a yearly contract basis which provides for several hours of burning nightly. Consequently in the case of ordinary 16-candlepower lamps the yield per lamp would be very far above the average. Moreover, it is customary to employ for part of such work lamps of higher candlepower. These conditions brought out by this table explain the facts.

Analogous conditions are exhibited by Table 25, which deals with composite private stations.

TABLE 25.—INCOME PER LAMP—COMPOSITE PRIVATE STATIONS, CLASSIFIED ACCORDING TO HORSEPOWER CAPACITY OF DYNAMOS: 1902.

HORSEPOWER CAPACITY OF DYNAMOS.	ARC LIGHTING.								
	Total.			Commercial or other private.			Public.		
	Income.	Number of lamps.	Income per lamp.	Income.	Number of lamps.	Income per lamp.	Income.	Number of lamps.	Income per lamp.
Total	$7,370,269	115,494	$63.82	$2,854,361	60,437	$47.23	$4,515,908	55,057	$82.02
Under 200	672,777	10,429	64.51	152,259	2,930	51.97	520,518	7,499	69.41
200 but under 500	1,163,709	17,261	67.42	351,770	6,183	56.89	811,939	11,078	73.29
500 but under 1,000	850,469	13,361	63.65	295,528	6,421	46.03	554,941	6,940	79.96
1,000 but under 2,000	1,158,251	16,768	69.08	414,098	7,791	53.15	744,153	8,977	82.90
2,000 but under 5,000	848,667	13,504	62.85	324,382	7,218	44.94	524,285	6,286	83.41
5,000 and over	2,676,396	44,171	60.59	1,316,324	29,894	44.03	1,360,072	14,277	95.26

HORSEPOWER CAPACITY OF DYNAMOS.	INCANDESCENT LIGHTING.								
	Total.			Commercial or other private.			Public.		
	Income.	Number of lamps.	Income per lamp.	Income.	Number of lamps.	Income per lamp.	Income.	Number of lamps.	Income per lamp.
Total	$13,215,015	5,153,543	$2.56	$12,448,431	5,048,502	$2.47	$766,584	105,041	$7.30
Under 200	2,105,263	675,234	3.12	1,908,256	655,014	2.91	197,007	20,220	9.74
200 but under 500	2,345,172	833,543	2.81	2,201,970	816,372	2.70	143,202	17,171	8.34
500 but under 1,000	1,397,354	556,876	2.51	1,321,753	548,377	2.41	75,601	8,499	8.90
1,000 but under 2,000	1,670,560	664,026	2.52	1,555,464	646,024	2.41	115,096	18,002	6.39
2,000 but under 5,000	1,305,166	588,215	2.22	1,201,569	574,636	2.09	103,597	13,579	7.63
5,000 and over	4,391,500	1,835,649	2.39	4,259,419	1,808,079	2.36	132,081	27,570	4.79

These stations had an average income of $63.82 per arc lamp. The average for commercial arc lamps was $47.23, while that for public lamps was $82.02. The classification by dynamo capacity shows that in commercial lighting the lamps in the smaller composite stations were paid for at a higher rate than those in the large stations, the income per lamp being $51.97 in stations of less than 200 horsepower, and $56.89 in stations of between 200 and 500 horsepower, while it was $44.94 in stations of 2,000 to 5,000 horsepower, and $44.03 in stations of 5,000 horsepower and upward. The composite stations had also somewhat the advantage as to public lighting, for, with an assumable economy in the production of current, the income per lamp was $82.02 as compared with $83.78 for purely electric stations. Where the plants were small, the composite stations were able to secure very good returns from public lighting. Composite stations of less than 200 horsepower had an income of $69.41 per lamp, as compared with $65.71 in the purely electric class; and composite plants of between 200 and 500 horsepower had an income of $73.29 per lamp, as compared with $69.07 in stations of the purely electric class.

The incandescent lighting business of composite stations was done with 5,153,543 incandescent lamps earning $13,215,015, or $2.56 per lamp. There were 5,048,502 lamps in commercial use earning $12,448,431, or $2.47 per lamp, and 105,041 public lamps earning $766,584, or $7.30 per lamp. It is certainly remarkable that the earnings of composite stations should be higher in both classes of service than the earnings of purely electric stations. The commercial incandescent business of the purely electric private plants brought in only $2.38 per lamp as compared with the $2.47 now noted, and the public lamps brought in only $5.57 as compared with $7.30. The classification shows that the benefit of the higher income was enjoyed largely by the group of stations of less than 200 horsepower, for which the income averaged $2.91 for commercial lamps and $9.74 for public lamps. The income from the commercial lamps on the circuits of the largest composite stations was slightly above that for the purely electric group, being $2.36 and $2.25, respectively, while the income from public lamps was decidedly higher in composite stations, being $4.79 in comparison with $2.73 for the purely electric stations. These variations are probably symptomatic, although they are due, in part, to the operation of certain specific stations where business had been developed largely along a given line on account of the desire of managers for a certain class of customers. While some central station managers are averse to public incandescent lighting business, others are willing

and glad to supply power for such purpose, and the same idiosyncrasies are seen in other departments of exploitation in the industry. A broad inference from Tables 24 and 25 is that, with the assumable economy in current production and the higher returns per arc and incandescent lamp, the composite stations should be on a more profitable basis than the purely electric ones. From this point of view the contention for consolidation of diverse businesses under one management, or within the one plant, is justified.

Tables 26 and 27 classify the income per lamp for the two groups of municipal stations according to the horsepower capacity of dynamos.

TABLE 26.—INCOME PER LAMP—PURELY ELECTRIC MUNICIPAL STATIONS, CLASSIFIED ACCORDING TO HORSEPOWER CAPACITY OF DYNAMOS: 1902.

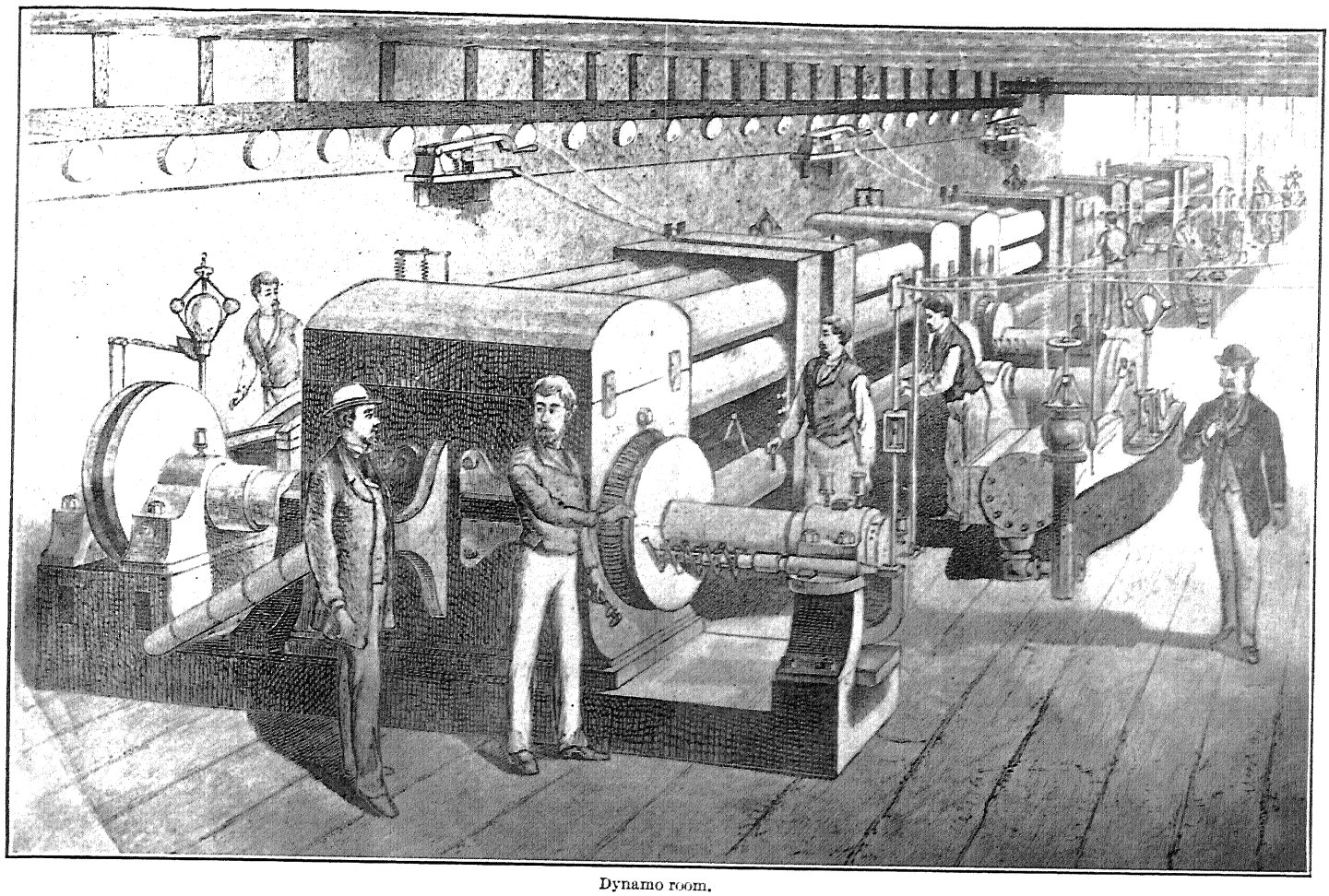
HORSEPOWER CAPACITY OF DYNAMOS.	ARC LIGHTING.								
	Total.			Commercial or other private.			Public.		
	Income.	Number of lamps.	Income per lamp.	Income.	Number of lamps.	Income per lamp.	Income [1]	Number of lamps.	Income per lamp.
Total	$2,276,193	32,998	$68.98	$151,390	3,682	$41.12	$2,124,803	29,316	$72.48
Under 200	539,058	8,809	61.19	37,168	773	48.08	501,890	8,036	62.46
200 but under 500	502,879	8,276	60.76	42,143	996	42.31	460,736	7,280	63.29
500 but under 1,000	223,020	4,077	54.70	42,525	1,330	31.97	180,495	2,747	65.71
1,000 but under 2,000	321,014	4,545	70.63	29,554	583	50.69	291,460	3,962	73.56
2,000 but under 5,000	186,289	2,829	65.85	.....	.....	.....	186,289	2,829	65.85
5,000 and over	503,933	4,462	112.94	.....	.....	.....	503,933	4,462	112.94

HORSEPOWER CAPACITY OF DYNAMOS.	INCANDESCENT LIGHTING.								
	Total.			Commercial or other private.			Public.		
	Income.	Number of lamps.	Income per lamp.	Income.	Number of lamps.	Income per lamp.	Income.[1]	Number of lamps.	Income per lamp.
Total	$1,732,235	785,868	$2.20	$1,423,538	732,929	$1.94	$308,697	52,939	$5.83
Under 200	759,744	298,697	2.54	641,433	285,397	2.25	118,311	13,300	8.90
200 but under 500	394,439	226,991	1.74	344,372	216,945	1.59	50,067	10,046	4.98
500 but under 1,000	324,674	163,725	1.98	292,431	157,038	1.86	32,243	6,687	4.82
1,000 but under 2,000	224,450	84,065	2.67	144,604	73,125	1.98	79,846	10,940	7.30
2,000 but under 5,000	28,428	12,190	2.33	698	424	1.65	27,730	11,766	2.36
5,000 and over	500	200	2.50	.....	.....	.....	500	200	2.50

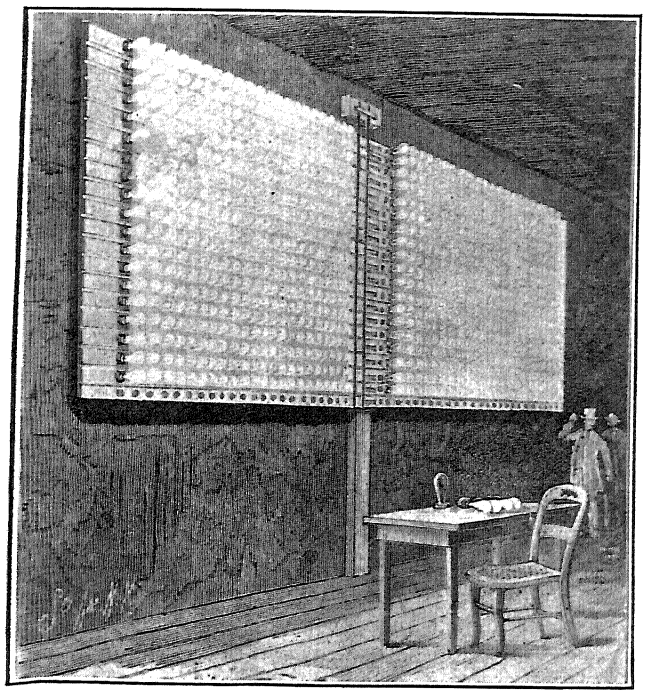
[1] Estimated according to prevailing rates.

The purely electric stations, with 32,998 arc lamps, had an income per lamp of $68.98. The income per commercial arc lamp was $41.12, while that of the public arc lamp was $72.48. For commercial lamps the rates of income did not differ greatly from those obtained by private plants, although in one class the rate was much lower. The income per commercial lamp for stations under 200-horsepower capacity was $48.08, but in the class between 500 and 1,000 horsepower it was only $31.97. In the next group, however, between 1,000 and 2,000 horsepower, it was $50.69, which was considerably higher than the figure for the corresponding private stations, which reported an income of only $46.92 per commercial arc lamp. The figures for the public arc lamps are higher than might be expected, but, as already stated, they have, in many instances, been estimated on the basis of private service in the same region. While this is a reasonable method of securing comparative data, it seems to operate to the disadvantage of the municipal stations. In other words, while the gross income derived by the municipal stations is increased on this basis and to that extent makes a better showing, it necessarily involves a higher ratio of income per lamp, which, in other words, means a higher charge or cost to the community for the service rendered.

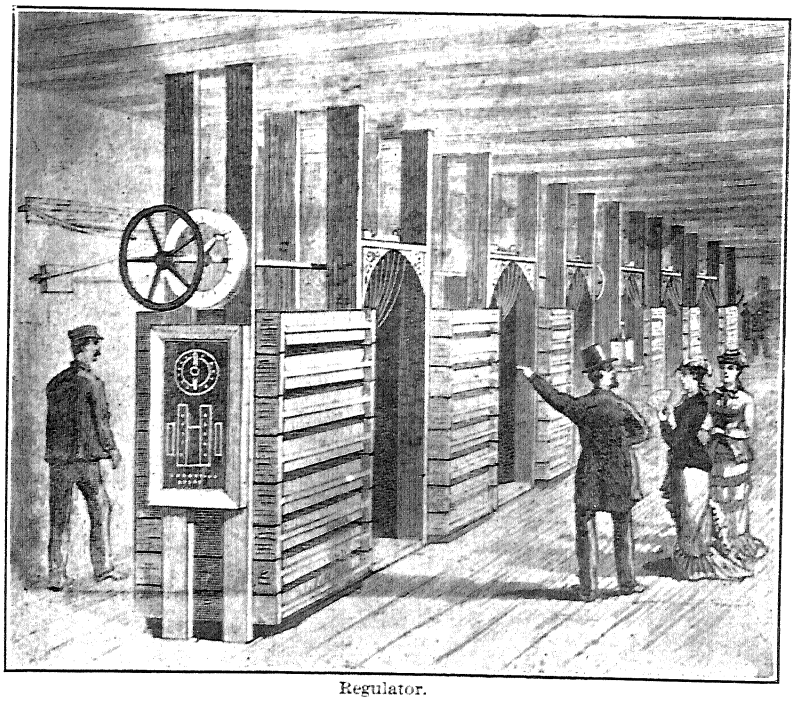
The figures for incandescent lighting show that the rate of income per lamp is lower in municipal stations than in private stations, this fact indicating superficially less effort to push this class of business in the municipal stations. For the purely electric municipal stations the average income per lamp was $2.20, while in the group of composite municipal stations it was $2.06 per lamp; similar averages for the two groups of private stations were $2.45 and $2.56. The income per commercial incandescent lamp of the purely electric municipal stations was $1.94—a still further indication, when taken with the return of $1.90 for the composite stations, of the small income derived from this class of service. The public lamps of these stations earned an average of $5.83 per lamp, although in the composite stations the average was $6.09. The variations in the purely electric municipal stations as to commercial and public incandescent lamps follow the same lines as those already considered in discussing the similar statistics for the private stations. The composite municipal stations, however, show some rather striking variations in Table 27.



Dynamo room.



Test battery of 1,000 lamps.



Regulator.

FIRST EDISON STATION IN NEW YORK CITY, PEARL STREET.

These views of the first Edison station in New York city show the first American dynamos direct connected to steam engines; also primitive regulating apparatus and testing group of a thousand lamps.

TABLE 27.—INCOME PER LAMP—COMPOSITE MUNICIPAL STATIONS, CLASSIFIED ACCORDING TO HORSEPOWER CAPACITY OF DYNAMOS: 1902.

HORSEPOWER CAPACITY OF DYNAMOS.	ARC LIGHTING.								
	Total.			Commercial or other private.			Public.		
	Income.	Number of lamps.	Income per lamp.	Income.	Number of lamps.	Income per lamp.	Income.[1]	Number of lamps.	Income per lamp.
Total	$1,113,052	17,797	$62.54	$88,776	2,111	$42.05	$1,024,276	15,686	$65.30
Under 200	639,914	10,406	61.49	40,714	868	46.91	599,200	9,538	62.82
200 but under 500	399,631	6,177	64.70	43,716	990	44.16	355,915	5,187	68.62
500 but under 1,000	46,286	583	79.39				46,286	583	79.39
1,000 but under 2,000	27,221	631	43.14	4,346	253	17.18	22,875	378	60.52
2,000 but under 5,000									
5,000 and over									

HORSEPOWER CAPACITY OF DYNAMOS.	INCANDESCENT LIGHTING.								
	Total.			Commercial or other private.			Public.		
	Income.	Number of lamps.	Income per lamp.	Income.	Number of lamps.	Income per lamp.	Income.[1]	Number of lamps.	Income per lamp.
Total	$1,627,383	791,583	$2.06	$1,444,758	761,602	$1.90	$182,625	29,981	$6.09
Under 200	1,004,832	463,124	2.17	886,489	443,947	2.00	118,343	19,177	6.17
200 but under 500	524,449	278,674	1.88	471,090	268,960	1.75	53,359	9,714	5.49
500 but under 1,000	30,568	16,160	1.89	20,775	15,570	1.33	9,793	590	16.60
1,000 but under 2,000	67,534	33,625	2.01	66,404	33,125	2.00	1,130	500	2.26
2,000 but under 5,000									
5,000 and over									

[1] Estimated according to prevailing rates.

The average income of commercial arc lamps was $42.05. In stations of between 1,000 and 2,000 horsepower the average was very low, being $17.18 per lamp, although the corresponding figure for public arcs was fairly up to the general average, being $60.52 per lamp, while the general average was $65.30. To reach this low figure of $17.18 it would be necessary to employ not only the smaller type of arc lamp, known as "half arcs," but to burn these a relatively short time and to charge a very low rate. As will be seen, this income applies to only 253 lamps, and must not be understood, therefore, to have any serious weight or bearing upon the general conclusions derivable from a study of income obtainable from 385,698 arc lamps of all classes.

The incandescent lighting of these composite municipal stations also presents some curious figures. The income from the commercial incandescent lamp fell as low as $1.33 per lamp in stations of between 500 and 1,000 horsepower, and yet, singularly, the income per public incandescent lamp in stations of the same size ran up to the high figure of $16.60, which is in excess of any other return recorded in any of these tables for such service. It applies, however, to but 590 lamps, and is therefore again entirely exceptional in its nature, and not in any sense characteristic.

Income per lamp of stations, classified according to population of places in which located.—Tables 28 to 31 present a series of statistics of stations, classified according to population of places in which located, with regard to the income from lighting, the number of lamps, and the income per lamp, for the purely electric and the composite private stations and the purely electric and the composite municipal stations.

TABLE 28.—INCOME PER LAMP—PURELY ELECTRIC PRIVATE STATIONS, CLASSIFIED ACCORDING TO POPULATION OF PLACES IN WHICH LOCATED: 1902.

POPULATION OF PLACES IN WHICH LOCATED.	ARC LIGHTING.								
	Total.			Commercial or other private.			Public.		
	Income.	Number of lamps.	Income per lamp.	Income.	Number of lamps.	Income per lamp.	Income.	Number of lamps.	Income per lamp.
Total	$14,721,531	219,409	$67.10	$5,365,793	107,743	$49.80	$9,355,738	111,666	$83.78
Under 5,000	1,784,903	28,766	62.05	462,129	8,590	53.80	1,322,774	20,176	65.56
5,000 but under 25,000	1,870,485	30,806	60.72	628,094	13,469	46.63	1,242,391	17,337	71.66
25,000 but under 100,000	2,457,083	40,676	60.41	858,589	19,949	43.04	1,598,494	20,727	77.12
100,000 but under 500,000	3,502,671	55,606	62.99	1,193,021	27,924	42.72	2,309,650	27,682	83.44
500,000 and over	5,106,389	63,555	80.35	2,223,960	37,811	58.82	2,882,429	25,744	111.97

TABLE 28.—INCOME PER LAMP—PURELY ELECTRIC PRIVATE STATIONS, CLASSIFIED ACCORDING TO POPULATION OF PLACES IN WHICH LOCATED: 1902—Continued.

POPULATION OF PLACES IN WHICH LOCATED.	INCANDESCENT LIGHTING.								
	Total.			Commercial or other private.			Public.		
	Income.	Number of lamps.	Income per lamp.	Income.	Number of lamps.	Income per lamp.	Income.	Number of lamps.	Income per lamp.
Total	$28,082,469	11,463,050	$2.45	$26,591,126	11,195,351	$2.38	$1,491,343	267,699	$5.57
Under 5,000	6,512,620	2,383,717	2.73	5,840,182	2,306,796	2.53	672,438	76,921	8.74
5,000 but under 25,000	3,562,386	1,458,719	2.44	3,299,706	1,420,795	2.32	262,680	37,924	6.93
25,000 but under 100,000	4,013,412	1,426,314	2.81	3,824,470	1,407,699	2.72	188,942	18,615	10.15
100,000 but under 500,000	5,055,736	2,357,842	2.14	4,951,942	2,341,412	2.11	103,794	16,430	6.32
500,000 and over	8,938,315	3,836,458	2.33	8,674,826	3,718,649	2.33	263,489	117,809	2.24

Purely electric private stations in cities of less than 5,000 inhabitants, as shown by Table 28, derived an income of $53.80 per lamp from commercial arc lighting, and $65.56 per lamp from public lighting. The prevalence of higher rates for commercial lighting in small places is shown by the figures for the next three smaller classes, although not in strict sequence as to size. The income per commercial lamp of stations in communities of between 5,000 and 25,000 inhabitants was $46.63, while in places of between 25,000 and 100,000 inhabitants it was $43.04, and in the places with a population of between 100,000 and 500,000 it fell to $42.72.

The highest return per commercial arc, $58.82, was obtained in cities of 500,000 inhabitants and over. This is also true of public arcs, the income being $111.97 per public arc. But while the income per commercial arc declined steadily in the various groups up to that for places with 500,000 inhabitants, it rose steadily throughout the whole scale as regards the income per public arc lamp. Some of the reasons for this have already been discussed and explained, and an additional reason is that as cities grow in size the obvious tendency and desire is to secure a better illumination of streets, and consequently the arc lamps are not burned on various limited, arbitrary or moonlight schedules, but are in service practically throughout the night the year around. Thus in the five different classes of places the income per public arc ran upward as follows: $65.56, $71.66, $77.12, $83.44, and, as already noted, $111.97.

The income per commercial incandescent lamp showed a very steady average for the various population groups; thus the income per lamp in communities of less than 5,000 inhabitants was $2.53, or slightly more than the average for all the groups, namely, $2.38. The income per lamp was $2.32 in communities of between 5,000 and 25,000 inhabitants, $2.72 in communities of between 25,000 and 100,000, $2.11 in communities of between 100,000 and 500,000, and $2.33 in cities of 500,000 and over. The public lighting with incandescent lamps showed much wider and sharper variations. It will be noted that while the average for all classes was $5.57 per lamp, it was $10.15 in communities of between 25,000 and 100,000 inhabitants, where street lighting with large incandescents is most prevalent, and was only $2.24 in the largest cities, where street lighting with incandescents is practically unknown, and where the service to public buildings would be closely analogous to that furnished commercial houses and residences.

In Table 29 figures are given for private stations operated in connection with other businesses.

TABLE 29.—INCOME PER LAMP—COMPOSITE PRIVATE STATIONS, CLASSIFIED ACCORDING TO POPULATION OF PLACES IN WHICH LOCATED: 1902.

POPULATION OF PLACES IN WHICH LOCATED.	ARC LIGHTING.								
	Total.			Commercial or other private.			Public.		
	Income.	Number of lamps.	Income per lamp.	Income.	Number of lamps.	Income per lamp.	Income.	Number of lamps.	Income per lamp.
Total	$7,370,269	115,494	$63.82	$2,854,361	60,437	$47.23	$4,515,908	55,057	$82.02
Under 5,000	878,602	13,647	64.38	232,731	4,166	55.86	645,871	9,481	68.12
5,000 but under 25,000	2,393,938	35,479	67.47	762,557	14,403	52.94	1,631,381	21,076	77.40
25,000 but under 100,000	1,333,139	21,663	61.54	538,001	12,125	44.37	795,138	9,538	83.37
100,000 but under 500,000	2,113,129	29,885	70.71	882,267	17,089	51.63	1,230,862	12,796	96.19
500,000 and over	651,461	14,820	43.96	438,805	12,654	34.68	212,656	2,166	98.18

TABLE 29.—INCOME PER LAMP—COMPOSITE PRIVATE STATIONS, CLASSIFIED ACCORDING TO POPULATION OF PLACES IN WHICH LOCATED: 1902—Continued.

POPULATION OF PLACES IN WHICH LOCATED.	INCANDESCENT LIGHTING.								
	Total.			Commercial or other private.			Public.		
	Income.	Number of lamps.	Income per lamp.	Income.	Number of lamps.	Income per lamp.	Income.	Number of lamps.	Income per lamp.
Total	$13,215,015	5,153,543	$2.56	$12,448,431	5,048,502	$2.47	$766,584	105,041	$7.30
Under 5,000	3,066,862	1,035,108	2.96	2,799,312	1,008,868	2.77	267,550	26,240	10.20
5,000 but under 25,000	3,779,997	1,429,518	2.64	3,540,084	1,397,358	2.53	239,913	32,160	7.46
25,000 but under 100,000	1,941,962	750,916	2.59	1,825,121	734,597	2.48	116,841	16,319	7.16
100,000 but under 500,000	2,387,984	1,121,732	2.13	2,280,399	1,098,648	2.08	107,585	23,084	4.66
500,000 and over	2,038,210	816,269	2.50	2,003,515	809,031	2.48	34,695	7,238	4.79

Some singular variations are shown in this table: For example, the income per commercial arc lamp in cities of 500,000 inhabitants and over was only $34.68, this fact implying the use of small arcs and limited hours of burning. The figures for public lighting are more consistent, although they show a tendency for the income per lamp to run lower in the largest communities included, probably as a result of the absence of underground conduits and subway rentals in the larger places where these composite plants operate. Indeed, in the smaller communities the returns per public arc were higher where composite plants were operated than where the plants were purely electric, although this might be due to the fact that in the communities of less than 100,000 inhabitants the purely electric stations were doing part of their public service with half arcs or that the varying use of inclosed arcs affected the rates charged and the similarity of the figures.

With regard to incandescent lighting it will be noted that the averages were higher in the composite stations than in the purely electric stations, being for commercial service $2.47 as compared with $2.38, and for public service $7.30 as compared with $5.57. In cities of between 100,000 and 500,000 inhabitants the income per commercial incandescent lamp was $2.08, this being the lowest return indicated anywhere in the table, while in communities of less than 5,000 inhabitants it was $2.77, which was the highest figure attained. The highest income per public incandescent lamp, $10.20, was also reached in that group; thus a very marked resort to incandescent lamps for street lighting is indicated for those places.

In Tables 30 and 31 are given the statistics of municipal stations on the basis of classified population.

TABLE 30.—INCOME PER LAMP—PURELY ELECTRIC MUNICIPAL STATIONS, CLASSIFIED ACCORDING TO POPULATION OF PLACES IN WHICH LOCATED: 1902.

POPULATION OF PLACES IN WHICH LOCATED.	ARC LIGHTING.								
	Total.			Commercial or other private.			Public.		
	Income.	Number of lamps.	Income per lamp.	Income.	Number of lamps.	Income per lamp.	Income.[1]	Number of lamps.	Income per lamp.
Total	$2,276,193	32,998	$69.98	$151,390	3,682	$41.12	$2,124,803	29,316	$72.48
Under 5,000	509,982	8,678	58.77	58,740	1,313	44.74	451,242	7,365	61.27
5,000 but under 25,000	602,458	9,900	60.85	65,643	1,614	40.67	536,815	8,286	64.79
25,000 but under 100,000	194,674	3,987	48.83	27,007	755	35.77	167,667	3,232	51.88
100,000 but under 500,000	319,186	4,544	70.24	.....	.....	.....	319,186	4,544	70.24
500,000 and over	649,893	5,889	110.36	.....	.....	.....	649,893	5,889	110.36

POPULATION OF PLACES IN WHICH LOCATED.	INCANDESCENT LIGHTING.								
	Total.			Commercial or other private.			Public.		
	Income.	Number of lamps.	Income per lamp.	Income.	Number of lamps.	Income per lamp.	Income.[1]	Number of lamps.	Income per lamp.
Total	$1,732,235	785,868	$2.20	$1,423,538	732,929	$1.94	$308,697	52,939	$5.83
Under 5,000	959,421	431,794	2.22	834,056	415,341	2.01	125,365	16,453	7.62
5,000 but under 25,000	496,659	265,676	1.87	430,275	253,519	1.70	66,384	12,157	5.46
25,000 but under 100,000	171,228	65,578	2.61	157,540	62,145	2.54	13,688	3,433	3.99
100,000 but under 500,000	99,427	21,620	4.60	1,667	1,924	0.87	97,760	19,696	4.96
500,000 and over	5,500	1,200	4.58	.....	.....	.....	5,500	1,200	4.58

[1] Estimated according to prevailing rates.

TABLE 31.—INCOME PER LAMP—COMPOSITE MUNICIPAL STATIONS, CLASSIFIED ACCORDING TO POPULATION OF PLACES IN WHICH LOCATED: 1902.

POPULATION OF PLACES IN WHICH LOCATED.	ARC LIGHTING.								
	Total.			Commercial or other private.			Public.		
	Income.	Number of lamps.	Income per lamp.	Income.	Number of lamps.	Income per lamp.	Income.[1]	Number of lamps.	Income per lamp.
Total	$1,113,052	17,797	$62.54	$88,776	2,111	$42.05	$1,024,276	15,686	$65.30
Under 5,000	657,479	10,933	60.14	64,231	1,359	47.26	593,248	9,574	61.96
5,000 but under 25,000	368,013	5,801	63.44	24,545	752	32.64	343,468	5,049	68.03
25,000 but under 100,000	66,310	813	81.56	.....	.....	.....	66,310	813	81.56
100,000 but under 500,000	.....	.....	.....	.....	.....	.....	.....	.....	.....
500,000 and over	21,250	250	85.00	.....	.....	.....	21,250	250	85.00

POPULATION OF PLACES IN WHICH LOCATED.	INCANDESCENT LIGHTING.								
	Total.			Commercial or other private.			Public.		
	Income.	Number of lamps.	Income per lamp.	Income.	Number of lamps.	Income per lamp.	Income.[1]	Number of lamps.	Income per lamp.
Total	$1,627,383	791,583	$2.06	$1,444,758	761,602	$1.90	$182,625	29,981	$6.09
Under 5,000	1,382,849	663,152	2.09	1,234,131	639,288	1.93	148,718	23,864	6.23
5,000 but under 25,000	227,734	125,969	1.81	210,627	122,314	1.72	17,107	3,655	4.68
25,000 but under 100,000	10,800	1,262	8.56	.....	.....	.....	10,800	1,262	8.56
100,000 but under 500,000	.....	.....	.....	.....	.....	.....	.....	.....	.....
500,000 and over	6,000	1,200	5.00	.....	.....	.....	6,000	1,200	5.00

[1] Estimated according to prevailing rates.

As has already been indicated, the bulk of the business of municipal stations was done in the smaller communities, namely, those not exceeding 25,000 in population. Thus, out of 17,797 arc lamps operated by composite municipal stations, 16,734 were in places of that size or under.

The income per commercial arc fell as low as $32.64. The income per public arc, as a result of the method of estimating, can be compared with the corresponding income of private stations, although the difference is in favor of the composite station. Thus the income per public arc of composite municipal stations was on the average $65.30, while for the purely electric stations it was $72.48.

The income per commercial incandescent lamp for purely electric stations was $1.94 and for the composite stations, $1.90.

Income from sources other than lighting.—In Table 13 it has been shown that the income derived from lighting by the central stations of the country constituted 81.8 per cent of the total. In that table the remaining income is divided into two classes, one being that from "all other electric service" and the other that from "all other sources," the former constituting 16.4 per cent of the total and the latter, 1.8 per cent; thus the income from these two classes formed 18.2 per cent of the entire earnings. Details as to income are given, by states and territories, in Table 68 for the private stations and in Table 78 for the municipal stations. In these tables the income from miscellaneous electric operation is broadly divided into five main classes.

Rates for motor service.—From the fact that power circuits connected with central stations draw their supply of current in the daytime, when a large proportion of the generating machinery would otherwise stand idle, a great many central stations have felt that they could make concessions and inducements in the way of special rates for current. These lower prices have enabled them to build up a new class of customers, and as a result of the increased income caused thereby they have been able to employ their machinery and operating staff a greater number of hours of the day and at a higher level of efficiency, as well as to employ more competent men and to pay better wages. So long as a company was restricted to a few hours of lighting its resources and income were limited, but with a business maintained not merely for a few hours of darkness, but carried on almost throughout the twenty-four hours, and with a fair proportion of the apparatus always in use, a large number of the stations were put into a better condition financially, and were enabled to carry out the developments and extensions that have been so marked a feature of the electric lighting industry during the past ten years. In fact, without the help of motors there would have been comparatively little incentive to introduce the many modern features which place electric current at the command of the consumer for all purposes, day and night.

The power rates deal, moreover, with current in large volume, and for this reason are lower than those for lighting. In some instances a flat rate was still charged, as, for example, $40 a year for 1 horsepower, $30 a year per horsepower for from 2 to 5 horsepower, and special rates for larger motors. Another common rate was from $1 per month for ¼-horsepower motor to $24.50 for 24 horsepower, and $1 per horsepower per month for 25 horsepower and upward. An average kilowatt hour rate for current was about 10 cents without discounts, but the actual rates ranged upward to 15 cents and downward to 3 cents and in some places a rate was quoted as low as 2 and 2½ cents. For fan motors special rates were often reported, as, for example, $2 to $3 per month during the summer months; as a general thing, however, the fan motor consumption through a meter has been paid for at the same kilowatt hour rate as that charged for incandescent lighting. The rates for power, moreover, have been subjected to varying discounts in the same manner as lighting. In some instances a minimum has been put into the power bill, as, for instance, $5 per month. At Niagara Falls, where current has been produced on a large scale, the kilowatt hour rate was 3 cents. The flat rate per year was $35 per horsepower up to and including 10 horsepower; $30 per horsepower up to and including 25 horsepower; and for quantities above 25 horsepower, $25 per horsepower.

Income of private stations from stationary motors.—It appears from Table 68 that the supply of current for motor service by private stations is now very general throughout the country, but some striking variations were presented. Motor service constituted somewhat over 12 per cent of the gross income and of the earnings from operation. As a general rule, income from motor service was most prominent in those states having abundant waterpower, and in the larger cities, where many small motors are used, thus avoiding the considerable cost of installing a steam plant. In New York the amount derived from motor service was $2,394,655, or over 14 per cent of the gross income of the private stations of the state. In California, however, striking testimony to the unusual development of power transmission enterprises in that state is again given by the fact that of the gross income of $4,937,444, not less than $1,217,379 was derived from the sale of current for stationary motor service. This is 24.6 per cent, or almost double the average for the country. In Illinois the motor service yield was $763,496, or 13.7 per cent of the gross income for the state, while in Massachusetts it was $741,103, or 12.2 per cent. The reports for Pennsylvania showed $639,860, which large sum, however, was only 7.1 per cent of the gross income of $9,057,503. The figures from Missouri are notable, the yield from motor service being $400,129, or nearly 19 per cent of the gross income of $2,121,604. The proportion in Colorado was also high, the motor service being $343,559, or 20.9 per cent of the gross income of $1,646,979. The proportion of the income from motor service to the gross income in South Carolina is striking, although the amounts are not large, the amount reported for motor service being $169,353 out of a total of $338,219. This is more than 50 per cent of the income, and is an example of the ideal condition desired by central station managers, but seldom attained by them, namely, of securing as much business and income during the daylight hours and from power load as from lighting during the hours of darkness. The only possible explanation for South Carolina is that the lighting interests there are quite small and undeveloped, while the state possesses some of the largest power transmission plants in the country, upon whose circuits are several of the largest cotton mills, requiring current throughout the day in great volume. In similar manner Utah had $156,331 derived from motor service out of a gross income of $711,483. This amounts to nearly 22 per cent, and, as in the case of Colorado and California, the high per cent can be explained by the existence of power transmission enterprises delivering current in large bulk for several hours daily to mining plants. If the income from stationary motor service supplied by stations operated by street railways, as shown in Table 97, were considered in connection with the above totals, some of the percentages would be changed.

Income of private stations from electric railway motor service.—The income from electric railway motor service supplied by private stations was reported as $2,301,343. Work of this kind was not done so generally as the stationary motor work, and the bulk of the income was derived from 5 states, namely, New York, $389,829; Pennsylvania, $324,749; New Jersey, $297,361; Massachusetts, $226,547; and California, $181,494. In this connection it might be stated that many small railways buy their power because they find it more economical than to operate their power plants for the small amount of current needed. Even some of the larger systems buy their power, but only when they can get it at a special rate, as in Buffalo, New York.

Income of private stations from electric heating and charging automobiles.—Neither electric heating nor the charging of automobiles shows up to advantage in regard to productive capacity. As seen in Table 68, the amount of income reported for electric heating by private stations was only $39,155, while the amount for charging automobiles was even less, being $29,959. A large proportion of the amount of the income from charging automobiles, namely, $13,650, is included in a group of "all other states," but should be credited to the District of Columbia, where electric automobile work has attained large proportions relatively to the rest of the

country. New York state also represented a large amount for charging automobiles, $12,685, so that the District of Columbia and New York account for $26,335 out of the $29,959. In like manner the reported business in electric heating was limited as to bulk to two or three states, of which Minnesota stood out in an extraordinary manner, with $24,289 out of $39,155 reported. Following in order came New York with $6,087; North Dakota, $6,000; and Pennsylvania, $1,182.

Electric heating was practically nonexistent in the Southern states according to the returns, although the moderate heat derivable in small quantities from electrical apparatus would appear to offer the stations in such regions an attractive field of effort.

Income of private stations from all other electric service.—Almost the entire amount for "all other electric service," $1,750,331, was reported from three states, namely, New York, $1,008,285; Montana, $257,336; and California, $227,500; although a number of other states reported small amounts. A large part of this income was received from the sale of current in bulk, as where one station sells current to another and has no means of knowing to what use it is put. It will be readily understood that in the larger cities, and particularly in New York city, industries of wide diversification called for current, while in the case of California and Montana—particularly the latter—it may be conjectured that considerable of the income noted was derived from electric mining operations, such as in electro-metallurgy, including the deposition of copper.

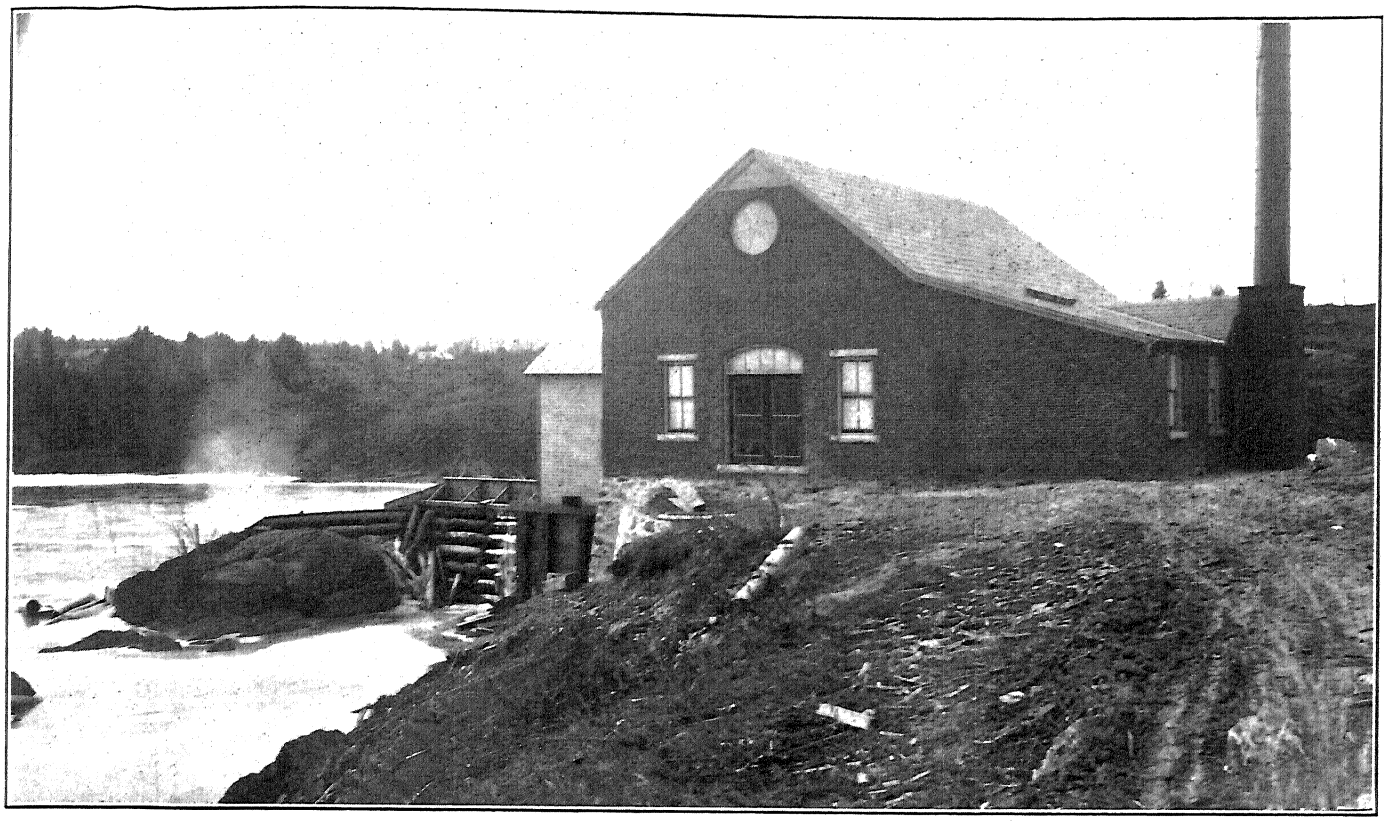
Electricity is employed in a great many industries which could hardly be classified as receiving service for light or power, among which might be mentioned electroplating and electro-deposition. In fact, the sale of current for all electro-chemical purposes would appear to fall into the category of miscellaneous electric service. In the same manner, large numbers of electric signs are now in use intended rather for advertising than for illumination, and these in the aggregate would represent a large amount of business which in many instances might not be brought to account specifically. For example, one incandescent lamp sign in New York city, fed with current from central station mains, contains 1,200 lamps, the initial letter being 68 feet high and covering several stories of the building upon which it is placed. It is needless to point out that 1,200 lamps burning steadily for several hours every night make a considerable demand for current which, even if sold at a low rate, would represent a large bill at the end of the year. Hundreds of such signs, large and small, are to be seen nightly in every one of the large cities of the country.

Where current is gauged by meter, central station managers are not able to ascertain definitely how much current should be charged up specifically to any branch of the service. Thus, for example, it has been more than once reported from New England that it was not until the extension of incandescent lighting circuits in certain communities or their discontinuance for repairs that the fact came to the surface that during the daytime electric heaters for cooking and other purposes were in regular use on some of them, and that people were thus seriously inconvenienced by the temporary discontinuance of the supply of current. In such cases it is obvious that the income from the sale of current for electric heating could not be calculated.

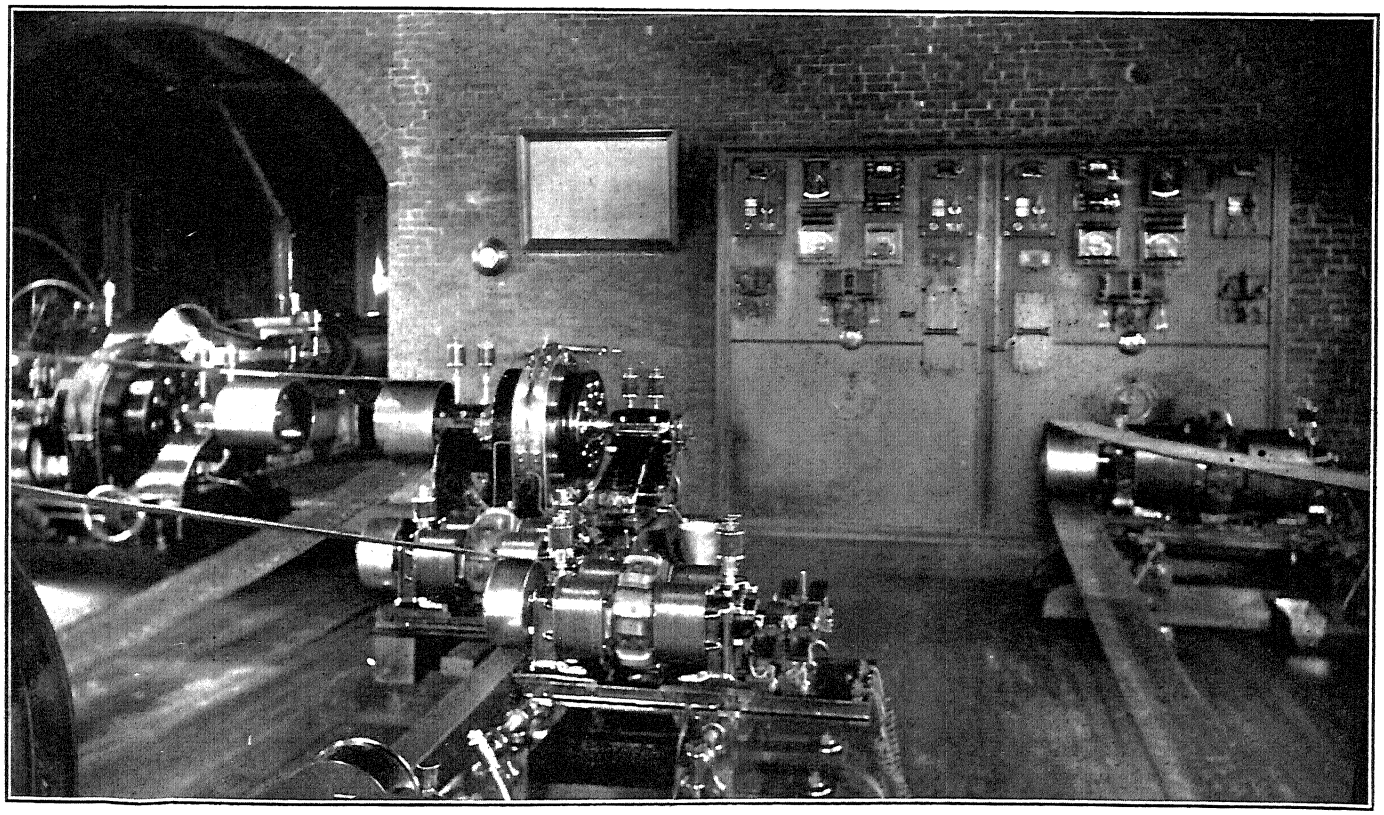
Income of private stations from all other sources.—Income from "all other sources" amounted to $1,385,751 and includes income derived from sale of electric supplies; wiring of houses; steam heating; hot water heating; rent of poles, meters, and motors; pumping; interest on deposits, etc. Every state and territory except Nevada reported some income from these sources, but in no case was the amount large enough to represent any considerable proportion of the whole. The four states reporting the largest amounts were Pennsylvania, $172,440; California, $113,405; New York, $112,313; and Massachusetts, $90,683. The amounts derived by the municipal stations from "all other sources" and from "all other electric service" are too small to disturb any conclusions that might be arrived at with regard to the business done by the private stations.

Miscellaneous income of municipal stations.—Table 78 gives an analysis of the miscellaneous income from municipal stations, by states and territories. It has already been pointed out that the business of municipal plants is almost entirely restricted to arc and incandescent lighting, so that of the total gross income of $6,965,105 all but $216,242 was received from these sources. The analysis of the sum of $87,993, returned for all electric service other than arc and incandescent lighting, shows that $70,540 of it was derived from stationary motor service; $3,172 from electric railway operation; $58 from electric heating; $97 from charging automobiles; and $14,126 from all other electric service. The supply of current for motor work was more general than might have been expected, 28 states and territories reporting income under this head. The amounts were considerable in some states, being $10,720 in California, $7,660 in Michigan, $5,525 in Ohio, $5,430 in Texas, $5,376 in Florida, $4,621 in Washington, $4,373 in Vermont, and $3,776 in Massachusetts. Only two states, California and Missouri, reported the supply of current for street cars, while only one state, Vermont, reported income from electric heating. The earnings from the charging of automobiles were also extremely restricted. In respect to the residue, lumped together as "all other electric service," it may be noted that of the total, $14,126, almost the entire amount was returned by three states, namely, New York, $8,500; Ohio, $2,505; and Pennsylvania, $1,459. The entire amount credited to New York was for power for police patrol boxes, etc., in Buffalo.

Under the head of "all other sources" an income of $128,249 was reported by the municipal stations. This



EXTERIOR VIEW OF EARLY BRUSH ARC LIGHTING PLANT AT ELLSWORTH, MAINE.



INTERIOR VIEW OF EARLY BRUSH ARC LIGHTING PLANT AT ELLSWORTH, MAINE.

sum was quite generally distributed among the states and territories, although not less than $39,404 was reported for Michigan, $14,696 for Indiana, and $14,533 for Iowa. Other leading states were Missouri with $9,017, Ohio with $6,971, and California with $6,922—the last-named state showing for its municipal stations as well as its private stations a remarkable diversification of income and an unusually large proportion from sources other than the standard arc and incandescent lighting upon which so many of the stations, whether carried on under private ownership or by municipalities, are inclined to depend, either from lack of enterprise or from want of opportunity. Of this income, all for California was from the sale of supplies, from wiring, etc.; $14,000 of that in Michigan was reported by the Detroit plant as coming from rent of poles and conduits, inspection, and foreign work; and in Massachusetts almost the entire amount was from the rent of meters and poles and from the sale of steampower.

Income of stations, classified according to population of places in which located.—Tables 32 to 35 present the general statistics of income for purely electric and composite private stations, and for purely electric and composite municipal stations, grouped according to the population of the places in which located.

TABLE 32.—ANALYSIS OF INCOME—PURELY ELECTRIC PRIVATE STATIONS, CLASSIFIED ACCORDING TO POPULATION OF PLACES IN WHICH LOCATED: 1902.

	Total.	POPULATION OF PLACES IN WHICH LOCATED.				
		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.
Number of stations	1,759	1,345	277	76	44	17
Gross income	$54,455,737	$9,654,207	$7,840,871	$8,521,413	$11,445,572	$16,993,674
Arc lighting, total	14,721,531	1,784,903	1,870,485	2,457,083	3,502,671	5,106,389
Commercial or other private	5,365,793	462,129	628,094	858,589	1,193,021	2,223,960
Public	9,355,738	1,322,774	1,242,391	1,598,494	2,309,650	2,882,429
Incandescent lighting, total	28,082,469	6,512,620	3,562,386	4,013,412	5,055,736	8,938,315
Commercial or other private	26,591,126	5,840,182	3,299,706	3,824,470	4,951,942	8,674,826
Public	1,491,343	672,438	262,680	188,942	103,794	263,489
Motor service	7,049,444	683,231	624,458	1,103,111	1,782,248	2,856,396
Electric railway service	1,869,569	153,512	477,294	556,396	645,015	37,352
Electric heating	6,064	3,740	835	100	207	1,182
Charging automobiles	26,245	286	332	630	13,997	11,000
All other electric service	1,638,836	274,925	1,072,898	78,232	212,781	.....
All other sources	1,061,579	240,990	232,183	312,449	232,917	43,040

It will be seen by Table 32 that the 1,759 purely electric private stations when treated on the basis of population fall very largely into the category of places of less than 5,000 inhabitants. There were 1,345 stations in such small towns and cities, and 1,622 in places having less than 25,000 inhabitants. The 1,345 stations had an aggregate income of $9,654,207, of which $1,784,903 was derived from arc lighting, and $6,512,620 from incandescent lighting. The other sources of income were all inconsiderable. A high proportion of income from lighting is shown in the group of places with between 5,000 and 25,000 inhabitants. The 277 stations in this class, with a gross income of $7,840,871, derived $1,870,485 from arc lighting and $3,562,386 from incandescent lighting. The miscellaneous sources of income, as will be seen from the table, were of more importance in this group, but were not so marked as in the next class of stations, namely, the 76 in places with between 25,000 and 100,000 inhabitants. Here the gross income was $8,521,413, with $2,457,083 derived from arc lighting and $4,013,412 from incandescent lighting, but the income from motor service reached $1,103,111, and that from electric railway service was $556,396. In fact, if all the items of miscellaneous service in this group be added together, they amount to $2,050,918, which is not greatly below the entire amount earned from arc lighting, and is far in excess of the amount derived from public arc lighting, a class of business upon which a great many stations of this size once depended almost wholly. The 44 purely electric private stations in cities of between 100,000 and 500,000 population had the large income of $11,445,572, with business well distributed through all the categories, namely: $3,502,671 from arc lighting; $5,055,736 from incandescent lighting; $1,782,248 from stationary motor service; and $645,015 from electric railway service.

The gross income for the 17 purely electric private stations in cities of a population of 500,000 and over formed a very large proportion of the total for all purely electric stations, namely, $16,993,674 out of $54,455,737.

The various sources of income seem to be much more carefully separated by the managements in this group than by those in any of the other groups, for out of a total income of $1,638,836 from "all other electric service," none is credited to the stations in this group; and out of the $1,061,579 income derived from "all other sources," only $43,040 is shown for this group. While the managements of these large stations undoubtedly are well informed as to the sources of income upon which their business is based, it is to be borne in mind that every one of these stations meters its current, so that it would be quite possible for part of the current going out over the incandescent lighting circuits to be credited to lamp consumption, although in fact it might be, and undoubtedly is, used for other purposes, which were duly noted in the smaller cities and towns. Some light is thrown on this point by a consideration of Table 43,

dealing with the per capita statistics of the 21 principal cities, including those 17 stations and some others of a composite character included in Table 6.

Table 33 deals with private stations operated in connection with other business.

TABLE 33.—ANALYSIS OF INCOME—COMPOSITE PRIVATE STATIONS, CLASSIFIED ACCORDING TO POPULATION OF PLACES IN WHICH LOCATED: 1902.

	Total.	POPULATION OF PLACES IN WHICH LOCATED.				
		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.
Number of stations	1,046	698	277	39	23	9
Gross income	$24,279,763	$4,340,587	$7,317.687	$3,803,482	$5,537,380	$3,280,627
Arc lighting, total	7,370,269	878,602	2,393,938	1,333,139	2,113,129	651,461
Commercial or other private	2,854,361	232,731	762,557	538,001	882,267	438,805
Public	4,515,908	645,871	1,631,381	795,138	1,230,862	212,656
Incandescent lighting, total	13,215,015	3,066,862	3,779,997	1,941,962	2,387,984	2,038,210
Commercial or other private	12,448,431	2,799,312	3,540,084	1,825,121	2,280,399	2,003,515
Public	766,584	267,550	239,913	116,841	107,585	34,695
Motor service	2,790,233	229,973	718,342	428,467	841,032	572,419
Electric railway service	431,774	9,216	243,153	54,013	125,392	.....
Electric heating	33,091	2,183	6,435	2,144	22,329	.....
Charging automobiles	3,714	105	1,031	141	2,437	.....
All other electric service	111,495	56,844	28,001	.....	12,497	14,153
All other sources	324,172	96,802	146,790	43,616	32,580	4,384

It is found that 698, or two-thirds of the 1,046 stations enumerated, were in places of a population of less than 5,000. There were 975 composite stations located in communities of less than 25,000 inhabitants. As a general thing the statistics in this table do not call for extensive comment as presenting notable points of difference.

It is rather a coincidence that in the class of places with between 5,000 and 25,000 inhabitants there should be exactly the same number of purely electric and of composite stations, namely, 277, and that the gross income for the two groups should be so nearly the same. In this population group the income from arc lighting amounted to $1,870,485 out of an aggregate of $7,840,871 for the purely electric stations, while in the composite stations the income amounted to $2,393,938 out of a total of $7,317,687, the proportion of income being much higher. The 9 composite stations in the group of cities with a population of 500,000 and over were by no means of a magnitude to compare with that of the 17 purely electric stations in cities of the same size. These composite stations had an income of only $3,280,627 out of the grand total of $24,279,763, whereas the purely electric stations had an income of $16,993,674 out of a grand total of $54,455,737, the relative proportions being therefore more than one-eighth and less than one-third. It is possible, however, that this comparison does not do full justice to the composite stations, since it may not embrace all the facts. Electric railways doing an electric business are shown in Table 97 to have received an income of $6,271,815 from the sale of electric current for light and power, which amount, if it could be properly brought into the statistics of composite electric lighting stations, would give them a position of greater magnitude and importance. With regard to these composite stations it is also to be noted that in the class of 500,000 and over the three items of electric railway service, electric heating, and charging automobiles disappear entirely, while the income from all the miscellaneous sources is also quite inconsiderable, falling below $20,000. Apparently the statistical effect of selling current by meter rather than for specific purposes or at a special flat rate is here shown.

Tables 34 and 35, dealing with the income of municipal stations, are very instructive as to the smallness of communities served by such plants, whether purely electric or associated with other business.

TABLE 34.—ANALYSIS OF INCOME—PURELY ELECTRIC MUNICIPAL STATIONS, CLASSIFIED ACCORDING TO POPULATION OF PLACES IN WHICH LOCATED: 1902.

	Total.	POPULATION OF PLACES IN WHICH LOCATED.				
		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.
Number of stations	380	288	73	10	6	3
Gross income[1]	$4,147,669	$1,526,686	$1,146,261	$378,094	$441,235	$655,393
Arc lighting, total	2,276,193	509,982	602,458	194,674	319,186	649,893
Commercial or other private	151,390	58,740	65,643	27,007	.....	.....
Public	2,124,803	451,242	536,815	167,667	319,186	649,893
Incandescent lighting, total	1,732,235	959,421	496,659	171,228	99,427	5,500
Commercial or other private	1,423,538	834,056	430,275	157,540	1,667	.....
Public	308,697	125,365	66,384	13,688	97,760	5,500
Motor service	51,075	13,556	24,796	12,137	586	.....
Electric railway service	3,172	.....	3,172	.....	.....	.....
Electric heating	58	58	.....	.....	.....	.....
Charging automobiles	20	20	.....	.....	.....	.....
All other electric service	13,686	5,062	124	.....	8,500	.....
All other sources	71,230	38,587	19,052	55	13,536	.....

[1] Includes estimated income from public lighting.

TABLE 35.—ANALYSIS OF INCOME—COMPOSITE MUNICIPAL STATIONS, CLASSIFIED ACCORDING TO POPULATION OF PLACES IN WHICH LOCATED: 1902.

	Total.	POPULATION OF PLACES IN WHICH LOCATED.				
		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.
Number of stations	435	383	48	3	.....	1
Gross income[1]	$2,817,436	$2,094,337	$618,739	$77,110	.....	$27,250
Arc lighting, total	1,113,052	657,479	368,013	66,310	.....	21,250
Commercial or other private	88,776	64,231	24,545	.....	.....	.....
Public	1,024,276	593,248	343,468	66,310	.....	21,250
Incandescent lighting, total	1,627,383	1,382,849	227,734	10,800	.....	6,000
Commercial or other private	1,444,758	1,234,131	210,627	.....	.....	.....
Public	182,625	148,718	17,107	10,800	.....	6,000
Motor service	19,465	9,524	9,941	.....	.....	.....
Electric railway service	.....	.....	.....	.....	.....	.....
Electric heating	.....	.....	.....	.....	.....	.....
Charging automobiles	77	77	.....	.....	.....	.....
All other electric service	440	440	.....	.....	.....	.....
All other sources	57,019	43,968	13,051	.....	.....	.....

[1] Includes estimated income from public lighting.

Of the 380 purely electric municipal stations, no fewer than 361 were in places of less than 25,000 inhabitants and 288 of them were in places of less than 5,000. Of the 435 composite stations, all but 4 were in places of less than 25,000 inhabitants and 383 were in places of less than 5,000 inhabitants. The income attributable to the purely electric stations in places with a population of less than 25,000 was $2,672,947 out of a total of $4,147,669. In the composite stations the proportion for the smallest places is overwhelming, being $2,094,337 out of a total of $2,817,436.

The disappearance of miscellaneous sources of income in the smaller centers of population is also brought out clearly by these two tables. In several of the classes the miscellaneous items are entirely wanting. The 288 purely electric stations in communities of less than 5,000 inhabitants derived, out of a total income of $1,526,686, only $13,556 from motor service and nothing from electric railway service; while the 73 stations in communities with between 5,000 and 25,000 inhabitants earned only $24,796 from motor service and $3,172 from electric railway service. This lack of diversity of income is also apparent in the composite stations; the 383 plants of this character in communities of less than 5,000 inhabitants, out of a total income of $2,094,337, derived only $9,524 from motor service and nothing from electric railway service. It is remarkable, however, that as to the division of income between the two classes of lighting, arc and incandescent, the smallest communities make returns showing a higher percentage of incandescent lighting. The purely electric stations in communities of less than 5,000 inhabitants reported an income from arc lighting of $509,982, as compared with $959,421 from incandescent lighting. Such results, however, would appear to be attributable in some respects to the use of incandescent lamps instead of arcs for street lighting, which would tend to bring the incandescent income up to the expense of the arc income. The figures for these items are even more striking for the composite municipal stations; the stations in communities of less than 5,000 inhabitants reported only $657,479 for arc lighting and $1,382,849 for incandescent lighting. In communities in the next group the relations of the figures for these items are reversed, although the same conditions would presumably hold good and afford the same explanation. The effect of restricting the business of municipal stations to the supply of current for street lighting with arcs is exemplified in these tables by the statistics of stations in cities of 100,000 inhabitants and upward. The 3 purely electric municipal stations in cities with a population of 500,000 and over reported an aggregate income of $655,393, of which all but $5,500 was due to arc lighting, while the single composite plant in the same group reported an aggregate income of $27,250, of which all but $6,000 was earned by arc lighting. All 4 of these plants in the larger cities earned their incomes from incandescent lighting by supplying public necessities, and not from commercial service.

Income of stations, classified according to dynamo capacity.—Income is brought under further analysis in Tables 36 to 39, which embody a classification according to the horsepower capacity of dynamos in exclusively electric private stations, composite private stations, exclusively electric municipal stations, and composite municipal stations, respectively.

TABLE 36.—ANALYSIS OF INCOME—PURELY ELECTRIC PRIVATE STATIONS, CLASSIFIED ACCORDING TO HORSEPOWER CAPACITY OF DYNAMOS: 1902.

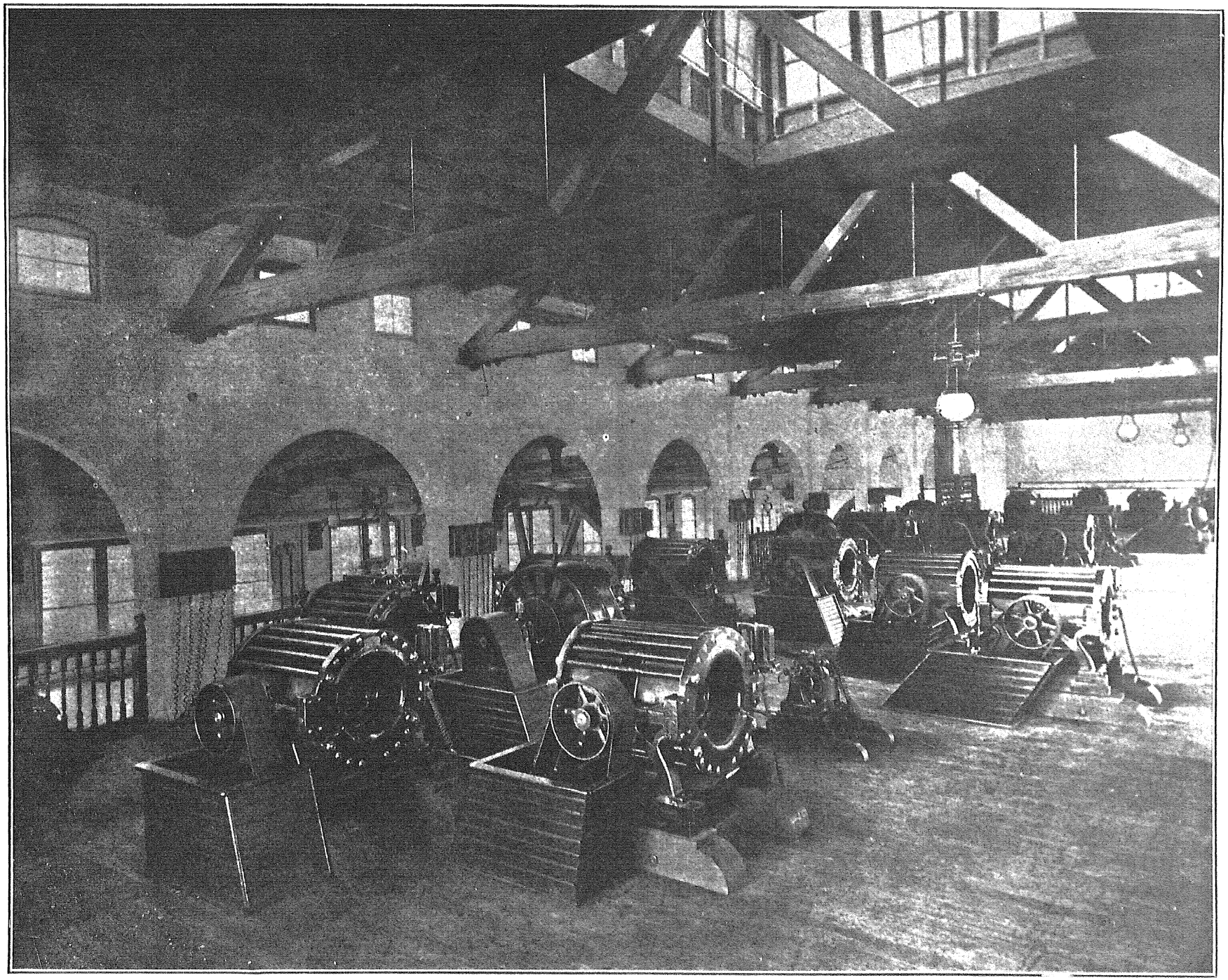
	Total.	HORSEPOWER CAPACITY OF DYNAMOS.					
		Under 200.	200 but under 500.	500 but under 1,000.	1,000 but under 2,000.	2,000 but under 5,000.	5,000 and over.
Number of stations	1,759	1,026	445	121	78	56	33
Gross income	$54,455,737	$4,999,517	$5,582,411	$3,585,065	$5,102,347	$8,639,398	$26,546,999
Arc lighting, total	14,721,531	1,036,360	1,371,498	988,447	1,563,861	2,507,585	7,253,780
Commercial or other private	5,365,793	248,062	400,941	301,796	638,111	861,046	2,915,837
Public	9,355,738	788,298	970,557	686,651	925,750	1,646,539	4,337,943
Incandescent lighting, total	28,082,469	3,711,212	3,688,358	1,988,136	2,378,876	3,617,887	12,698,000
Commercial or other private	26,591,126	3,304,222	3,349,070	1,827,663	2,229,011	3,525,092	12,356,068
Public	1,491,343	406,990	339,288	160,473	149,865	92,795	341,932
Motor service	7,049,444	61,561	239,310	327,639	659,826	1,489,390	4,271,718
Electric railway service	1,869,569	36,198	62,143	206,357	219,354	420,989	924,528
Electric heating	6,064	274	439	3,637	225	100	1,389
Charging automobiles	26,245	36	250	.....	462	500	24,997
All other electric service	1,638,836	6,831	31,392	4,207	115,096	369,692	1,111,618
All other sources	1,061,579	147,045	189,021	66,642	164,647	233,255	260,969

In Table 36 are presented the figures for the purely electric private plants, for which there was an aggregate income of $54,455,737 from all sources; the two principal sources were arc lighting with $14,721,531, and incandescent lighting with almost twice as much, namely, $28,082,469. The statistics for dynamos classified according to the various capacities show that 33 plants with a capacity of 5,000 horsepower and upward earned about one-half of the income, namely, $26,546,999, but that relatively the proportion of income from incandescent lighting to that from arc lighting in that group fell off slightly—the arc lighting income being $7,253,780, while the incandescent lighting was $12,698,000.

In the group of stations with dynamo capacity of less than 200 horsepower, incandescent lighting formed a surprisingly large proportion of the total, being $3,711,212 out of a total of $4,999,517. In the next group of 445 stations the aggregate income was $5,582,411, of which amount $1,371,498 was for arc lighting and $3,688,358 was for incandescent lighting. The aggregate income shown for the stations having a capacity of between 500 and 1,000 horsepower amounted to only $3,585,065, of which $988,447 represented arc lighting and $1,988,136 incandescent lighting. This group had the smallest earnings. The aggregate earnings of the group of 78 stations with between 1,000 and 2,000 horsepower were $5,102,347, of which $1,563,861 were from arc lighting and $2,378,876 from incandescent lighting. The group of 56 stations of between 2,000 and 5,000 horsepower capacity earned an aggregate of $8,639,398, of which $2,507,585 was for arc lighting and $3,617,887 was for incandescent lighting. A further study of the table shows that miscellaneous income was derived from stations in all classes, but that, as might be expected, the largest plants had by far the largest proportion of income derived from other sources than mere lighting. Thus the 33 plants of 5,000 horsepower and over, out of a total income of $26,546,999, showed $6,595,219, or 24.8 per cent, derived from the various miscellaneous services and sources of income.

On the other hand the stations having a dynamo capacity of less than 200 horsepower and earning a gross income of $4,999,517 reported a total income from miscellaneous sources of only $251,945. This is only 5 per cent. Many of the causes that have already been suggested would account for this. The leading factor, of course, is the general absence of day circuits in connection with such small plants as a result of the scarcity of local industries and enterprises calling for current in the daylight hours. This point is emphasized by the fact that these stations earned only $61,561 from the supply of current to stationary motors, or about $60 a year each; this condition of affairs shows that the business "in sight" was either entirely negligible or that no effort had been made to work it up. As the plants grow in size these hampering conditions tend to ameliorate, as shown by this table. For example, in plants of between 200 and 500 horsepower dynamo capacity, out of a gross income of $5,582,411, the income from miscellaneous sources was $522,555, or 9.4 per cent. In the group with a capacity between 500 and 1,000 horsepower, out of a gross income of $3,585,065, the income from all miscellaneous sources was $608,482, or 17 per cent. In the next group—that of plants of between 1,000 and 2,000 horsepower capacity—out of a gross income of $5,102,347, the miscellaneous income was $1,159,610, or 22.7 per cent. In the group of stations of between 2,000 and 5,000 horsepower capacity the gross income was $8,639,398 and the income derived from all miscellaneous sources was $2,513,926, or 29.1 per cent. It is thus made very clear that there is from the smallest station upward a sharp increase in the percentage of income derivable from business other than lighting, the probability being that the percentages for the two classes with a capacity of more than 2,000 horsepower are more nearly alike than they appear to be on the surface. Both groups illustrate the steady advance toward securing a large amount of business in the daytime and a high load factor for the system throughout the twenty-four hours.

Table 37 deals with private stations operated in connection with other business.



EARLY THOMSON-HOUSTON ARC LIGHTING STATION AT LOWELL, MASS., BELT DRIVEN.

TABLE 37.—ANALYSIS OF INCOME—COMPOSITE PRIVATE STATIONS, CLASSIFIED ACCORDING TO HORSEPOWER CAPACITY OF DYNAMOS: 1902.

	Total.	HORSEPOWER CAPACITY OF DYNAMOS.					
		Under 200.	200 but under 500.	500 but under 1,000.	1,000 but under 2,000.	2,000 but under 5,000.	5,000 and over.
Number of stations	1,046	624	255	80	48	25	14
Gross income	$24,279,763	$2,925,026	$3,869,430	$2,653,918	$3,353,809	$2,763,537	$8,714,043
Arc lighting, total	7,370,269	672,777	1,163,709	850,469	1,158,251	848,667	2,676,396
Commercial or other private	2,854,361	152,259	351,770	295,528	414,098	324,382	1,316,324
Public	4,515,908	520,518	811,939	554,941	744,153	524,285	1,360,072
Incandescent lighting, total	13,215,015	2,105,263	2,345,172	1,397,354	1,670,560	1,305,166	4,391,500
Commercial or other private	12,448,431	1,908,256	2,201,970	1,321,753	1,555,464	1,201,569	4,259,419
Public	766,584	197,007	143,202	75,601	115,096	103,597	132,081
Motor service	2,790,233	79,035	206,215	275,401	351,234	438,517	1,439,831
Electric railway service	431,774	7,811	48,419	80,007	97,572	41,214	156,751
Electric heating	33,091	2,020	163	6,000	22,704	1,654	550
Charging automobiles	3,714	105	670	547	.....	80	2,312
All other electric service	111,495	6,320	16,096	.....	4,520	72,062	12,497
All other sources	324,172	51,695	88,986	44,140	48,968	56,177	34,206

In this group 1,046 stations are included with a gross income of $24,279,763, of which $7,370,269 resulted from arc lighting and $13,215,015 from incandescent lighting. Thus in the composite stations $20,585,284, or 84.8 per cent of the income, was derived from lighting. These figures compare rather strikingly with those for the purely electric stations, which with a gross income of $54,455,737 had an income from lighting alone of $42,804,000, or only 78.6 per cent. The inference is that the purely electric stations as a whole had a more diversified business and more varied sources of income than the composite stations.

The 14 composite stations of a dynamo capacity of at least 5,000 horsepower had an income from all miscellaneous sources of $1,646,147, or 18.9 per cent, out of a total of $8,714,043. This compares with 24.8 per cent in the corresponding class among purely electric stations. It is interesting to note, moreover, that while the 33 stations in the largest group in the purely electric class earned about one-half of the total income for that class, the composite stations of the same rank earned only a little more than one-third of the income of composite stations.

From the fact that composite stations are those which are carried on in connection with other business, it would be fair to infer that it would be much easier for the smaller stations in this group to render service in the daytime than it would be for the purely electric stations of the same minor magnitude, for the reason that the steam or water plant would presumably be in operation all the time, and that it would therefore be a matter of no great difficulty to throw a small dynamo onto the shafting and into circuit to supply current for light, power, and other service. This inference, however, is not borne out as fully as might be expected by the figures shown in this table, although the influence of the lack of daylight demand can be understood. For instance, the 1,026 purely electric stations of less than 200 horsepower capacity derived $61,561 from motor service and $36,198 from electric railway service, 1.2 and seven-tenths of 1 per cent, respectively, of their total income, while the 624 composite stations of less than 200 horsepower capacity earned from motor service $79,035, which was 2.7 per cent of their income, but secured from electric railway work only $7,811, or three-tenths of 1 per cent of the income. Leaving the supply of current to electric railways out of consideration, however, it would appear that the smaller stations, namely, all those with a dynamo capacity below 1,000 horsepower, did relatively a larger amount of motor business. In the purely electric class the three groups, with a capacity below 1,000 horsepower, earned $628,510 from stationary motor service, only slightly over 4 per cent of their gross income. The corresponding stations below 1,000 horsepower dynamo capacity in the composite class derived an income from motor service of $560,651, or not quite 6 per cent. A greater difference in favor of the composite class might have been expected.

In Table 38 are presented analyses similar to the above, for purely electric municipal stations.

TABLE 38.—ANALYSIS OF INCOME—PURELY ELECTRIC MUNICIPAL STATIONS, CLASSIFIED ACCORDING TO HORSEPOWER CAPACITY OF DYNAMOS: 1902.

	Total.	HORSEPOWER CAPACITY OF DYNAMOS.					
		Under 200.	200 but under 500.	500 but under 1,000.	1,000 but under 2,000.	2,000 but under 5,000.	5,000 and over.
Number of stations	380	269	78	22	8	2	1
Gross income[1]	$4,147,669	$1,340,157	$925,393	$595,141	$554,156	$228,389	$504,433
Arc lighting, total	2,276,193	539,058	502,879	223,020	321,014	186,289	503,933
Commercial or other private	151,390	37,168	42,143	42,525	29,554	.....	.....
Public	2,124,803	501,890	460,736	180,495	291,460	186,289	503,933
Incandescent lighting, total	1,732,235	759,744	394,439	324,674	224,450	28,428	500
Commercial or other private	1,423,538	641,433	344,372	292,431	144,604	698	.....
Public	308,697	118,311	50,067	32,243	79,846	27,730	500
Motor service	51,075	6,693	7,838	27,934	8,474	136	.....
Electric railway service	3,172	.....	.....	3,172	.....	.....	.....
Electric heating	58	50	8	.....	.....	.....	.....
Charging automobiles	20	20	.....	.....	.....	.....	.....
All other electric service	13,686	9,983	3,603	100	.....	.....	.....
All other sources	71,230	24,609	16,626	16,241	218	13,536	.....

[1] Includes estimated income from public lighting.

The 380 purely electric stations enumerated had a gross income of $4,147,669, of which $2,276,193 was derived from arc lighting and $1,732,235, from incandescent lighting. These stations derived from miscellaneous business of all kinds an income of only $139,241, which is barely over 3 per cent of the gross income. On the other hand, a noteworthy reversal of conditions is implied in the statistics as to the two classes of lighting. In the private stations, both purely electric and composite, the income derived from incandescent lighting was very much in excess of that from arc lighting, being almost twice as much; whereas in the purely electric municipal stations, the income from incandescent lighting was considerably less than that from arc lighting, being for the latter $2,276,193, as compared with $1,732,235 for the former. As will be noted later, the composite municipal stations in some respects more nearly resemble the composite private stations.

The horsepower classification of municipal plants brings out very clearly the preponderating character and influence of the smaller plants. The reports showed but one plant of a capacity above 5,000 horsepower, and its income was only 12.2 per cent of the total for the 380 plants included. On the other hand, the 33 purely electric private stations of similar capacity enjoyed 48.7 per cent of the total income of the 1,759 stations of their own character. The 269 purely electric municipal stations of less than 200 horsepower had a gross income of $1,340,157, or 32.3 per cent of the total for all stations. In fact, the two groups most prominent as to earnings are those of less than 200 horsepower and those of between 200 and 500 horsepower, the latter class with 78 stations showing a gross income of $925,393. These two groups, in fact, had a gross income of more than one-half of all the income of their class.

Table 39 shows the analysis of the income of municipal stations operated in connection with other business.

TABLE 39.—ANALYSIS OF INCOME—COMPOSITE MUNICIPAL STATIONS, CLASSIFIED ACCORDING TO HORSEPOWER CAPACITY OF DYNAMOS: 1902.

	Total.	HORSEPOWER CAPACITY OF DYNAMOS.					
		Under 200.	200 but under 500.	500 but under 1,000.	1,000 but under 2,000	2,000 but under 5,000.	5,000 and over.
Number of stations	435	343	86	3	3		
Gross income[1]	$2,817,436	$1,679,501	$959,479	$77,154	$101,302		
Arc lighting, total	1,113,052	639,914	399,631	46,286	27,221		
Commercial or other private	88,776	40,714	43,716		4,346		
Public	1,024,276	599,200	355,915	46,286	22,875		
Incandescent lighting, total	1,627,383	1,004,832	524,449	30,568	67,534		
Commercial or other private	1,444,758	886,489	471,090	20,775	66,404		
Public	182,625	118,343	53,359	9,793	1,130		
Motor service	19,465	7,205	6,470	300	5,490		
Electric railway service							
Electric heating							
Charging automobiles	77	77					
All other electric service	440	40	400				
All other sources	57,019	27,433	28,529		1,057		

[1] Includes estimated income from public lighting.

Of the private stations 1,759 were purely electric and only 1,046 were composite; the proportion, however, is reversed in the case of the municipal stations, 380 of these being purely electric while 435 were composite. This excess of composite stations is due to the very general tendency to operate several municipal enterprises together, which, while it has its advantages in an economic sense, renders difficult the segregation of figures relative to any branch or department. According to the classification in this table, 343 stations, with an income of $1,679,501, or considerably more than half the total income for the class, had a dynamo capacity of less than 200 horsepower. In fact, all but 6 of the composite stations were of a capacity below 500 horsepower, and the income of these 429 stations was $2,638,980, or an average of $6,151, a very clear indication of the small magnitude of business done by the average plant of this character. It is to be noted that the electric motor service income was very small, namely, only $19,465, or less than 1 per cent of the gross income; this fact is somewhat counter to the deductions drawn from the previous table, and would indicate that while the purely electric stations, under whatever form of administration, cultivated a miscellaneous and diversified daytime business, the municipal stations of a composite physical character have neglected outside business altogether. This is explained by the obvious reason that the majority of these plants are in very small communities where there is no call for anything electric more than public lighting, and where even that is restricted to a limited number of arc or incandescent lamps. It is a little curious, however, to note that a few of these small plants had established the beginning of a business in electric heating and charging of automobiles.

Average income per horsepower of dynamo capacity.—For the various states and territories the details of income as to earnings from operation are presented, for

all stations, in Table 66; for private stations separately in Tables 67 and 68; and for municipal stations separately in Tables 77 and 78. Other general tables present different aspects of the subject.

The earnings from sale of current by the private stations amounted to $77,349,749, and this amount represents the earning power of the dynamo electric machinery installed. The earnings follow capacity with fair closeness, although the extent of equipment varies in the different states, being especially large in the more densely populated parts of the country, and particularly in the Northern states.

New York, with a dynamo capacity in private stations of 245,823 horsepower, reported earnings from sale of current of $16,519,489, which gives average annual earnings per dynamo horsepower of $67.20. Pennsylvania, with 155,377 horsepower and earnings of $8,885,063, had an average of $57.18 per horsepower. Missouri, with 37,150 horsepower and earnings of $2,098,622, showed an average of $56.49 per horsepower. New Jersey, with 60,361 horsepower, reported earnings of $3,313,946, or $54.90 per horsepower. Massachusetts, with 114,928 horsepower and earnings of $5,979,960, averaged $52.03 per horsepower. Illinois, with 110,334 horsepower and earnings of $5,514,569, averaged $49.98, while for Ohio, with 76,276 horsepower and earnings of $3,652,778, the figure was $47.89. California, with 110,381 horsepower and earnings of $4,824,039, averaged $43.70 per horsepower, while Michigan, with 42,133 horsepower and earnings amounting to $1,798,106, averaged $42.68 per horsepower. It would hardly be expected that the average for Alabama would be higher than that for Connecticut, and nearly as high as that for New York, but the returns show this to be the case; the average for Alabama was $64.25 per horsepower, as compared with $67.20 for New York and $62.70 for Connecticut, for which state the horsepower was 20,279 and the income from the sale of current $1,271,576. There was a high average also in North Dakota, which had a capacity of 2,096 horsepower and earnings of $142,891, and therefore an average of $68.17 per horsepower.

Such variations seem to prove the existence of much higher rates in some localities than in others where there is not a large volume of business, although in some cases they might also be due to the fact that while some managements carry considerable reserve capacity in their stations as a safeguard against interruption by breakdown, others operate all the plant installed to its highest point of output, depending upon vigilance and good fortune to escape trouble. In some instances, also, the returns for the plant were made at a time when additions had become necessary but had not yet been installed, with the result that the station appears to have had an earning power much above its average.

From such figures as these it is obviously very difficult to deduce any general rule or formulate any statement which would be both exact and comprehensive as to the conditions under which the plants were or can be operated to the greatest financial advantage. The subject is considered later with respect to the earning power of the consumption apparatus to which current is distributed, with additional data and suggestions useful as bearing upon features of management and the benefit afforded to the public, as well as the profit to the station from the cultivation of certain lines of business.

Average income per kilowatt hour.—It is interesting to look at the earning capacity of dynamos from another point of view, namely, that of their gross output of current and the value of said current to the central stations producing it. The output in current of private stations with a dynamo capacity of 1,472,996 horsepower was reported in Table 1 as being 2,311,146,676 kilowatt hours for the year. This output earned $77,349,749. This would represent 3.35 cents per kilowatt hour, without taking into account how much of the kilowatt hour output was actually delivered to the customer and registered by his meter or sold at a flat rate. Such a return is very far below the average price obtained for current supplied in limited quantities to the small consumer, thus indicating a relatively low return per unit of current.

The output for municipal stations was returned at 195,904,439 kilowatt hours, and the income from sale of current including the estimated income from public service, at $6,836,856. These figures show an earning per kilowatt hour for the municipal stations of 3.49 cents, which average it will be noted does not differ greatly from the corresponding earnings for private stations. A less close approximation than this, favoring the municipal plants, might have been expected in view of the assumed lower capitalization and fixed charges, etc., upon which the municipal stations have to operate.

The income varied from one state to another, although not in such a manner as to afford a common rule or basis. For example, in New York the earnings per kilowatt hour for private stations were only 2.38 cents. It will be recalled that the state of Alabama showed almost as high earning per horsepower of dynamo capacity as New York, but the earnings per kilowatt hour were only 3.12 cents. The output in California was 150,338,307 kilowatt hours and the earnings from operation, $4,824,039, which gives an average of 3.2 cents. Kilowatt hour earnings for other leading states may be noted as follows: Pennsylvania, 3.86 cents; Illinois, 4.12 cents; Massachusetts and Connecticut, 4.91 cents each; New Jersey, 4.26 cents; Iowa, 4.12 cents; Washington, 3.15 cents; Michigan, 3.12 cents; Maine, 3.06 cents; and New Hampshire, 3.04 cents.

Cost and income of stations, classified according to kind of power used.—It will have been noticed from preceding tables that a considerable part of the central station industry is based upon the utilization of waterpower. More exact figures bearing upon this point are to be found in Tables 40 and 41, which present statistics of private and municipal stations under the heads of stations operating by steampower exclusively, stations operating by steam and water power conjointly, and stations operating by waterpower exclusively. The last class, those in which waterpower alone is employed for power purposes, is shown by states in Table 42.

TABLE 40.—STATISTICS OF PRIVATE STATIONS, CLASSIFIED ACCORDING TO KIND OF POWER USED: 1902.

	Total.	KIND OF POWER USED.		
		Steam exclusively.	Water and steam.	Water exclusively.
Number of stations	2,805	2,211	316	278
Cost of construction and equipment	$482,719,879	$324,267,907	$121,230,534	$37,221,438
Gross income	$78,735,500	$62,402,880	$12,448,955	$3,883,665
Income from sale of current	$77,349,749	$61,459,052	$12,118,835	$3,771,862
Arc lighting, total	$22,091,800	$18,213,239	$3,452,975	$425,586
Commercial or other private	$8,220,154	$6,771,656	$1,290,043	$158,455
Public	$13,871,646	$11,441,583	$2,162,932	$267,131
Incandescent lighting, total	$41,297,484	$34,267,778	$5,542,223	$1,487,483
Commercial or other private	$39,039,557	$32,436,310	$5,207,661	$1,395,586
Public	$2,257,927	$1,831,468	$334,562	$91,897
All other electric service	$13,960,465	$8,978,035	$3,123,637	$1,858,793
Income from all other sources	$1,385,751	$948,828	$330,120	$111,803
Total expenses[1]	$50,716,648	$39,804,490	$8,600,271	$2,311,887
Salaries and wages	$18,766,970	$14,528,959	$3,116,580	$1,121,431
Cost of supplies and materials	$8,296,763	$5,731,661	$2,283,741	$281,361
Cost of fuel	$10,189,685	$9,065,375	$1,119,505	$4,805
Rent of power	$2,007,193	$1,418,459	$322,522	$266,212
Rents, taxes, insurance, and miscellaneous expenses	$11,456,037	$9,060,036	$1,757,923	$638,078
Salaried officials, clerks, etc.:				
Number	6,046	4,759	898	389
Salaries	$5,206,199	$3,991,895	$870,754	$343,550
Wage-earners:				
Average number	20,863	16,711	2,976	1,176
Wages	$13,560,771	$10,537,064	$2,245,826	$777,881
Power plant equipment:[2]				
Steam and gas engines—				
Number	5,017	4,445	572	.....
Horsepower	1,244,147	1,080,938	163,209	.....
Water wheels—				
Number	1,308	.....	754	554
Horsepower	427,254	.....	219,123	208,131
Generating plant equipment:				
Dynamos—				
Number	10,662	8,356	1,636	670
Horsepower	1,472,996	1,007,858	299,865	165,273
Direct current, constant voltage—				
Number	3,405	2,753	480	172
Horsepower	418,913	339,824	63,617	15,472
Direct current, constant amperage—				
Number	2,957	2,362	502	93
Horsepower	157,768	125,728	27,827	4,213
Alternating and polyphase current—				
Number	4,300	3,241	654	405
Horsepower	896,315	542,306	208,421	145,588
Output of stations, kilowatt hours, total for year	2,311,146,676	1,387,265,622	675,131,386	248,749,668
Number of arc lamps	334,903	273,166	54,360	7,377
Number of incandescent lamps	16,616,593	13,960,076	2,145,101	511,416

[1] Exclusive of interest on bonds amounting to $12,118,740.
[2] Does not include 329 auxiliary steam engines with a total capacity of 13,619 horsepower.

It will be seen from Table 40 that of the 2,805 private stations whose cost of construction and equipment was $482,719,879, 2,211, costing $324,267,907, employed steam exclusively; 316, costing $121,230,534, employed water and steam conjointly; and 278, or almost 10 per cent, were operated by waterpower exclusively, their cost of construction and equipment being $37,221,438. The earnings from the sale of current by these three groups were $61,459,052, $12,118,835, and $3,771,862, respectively.

In like manner Table 41 furnishes an interesting classification of municipal stations according to the kind of power used.

TABLE 41.—STATISTICS OF MUNICIPAL STATIONS, CLASSIFIED ACCORDING TO KIND OF POWER USED: 1902.

	Total.	KIND OF POWER USED.		
		Steam exclusively.	Water and steam.	Water exclusively.
Number of stations	815	768	13	34
Cost of construction and equipment	$22,020,473	$20,351,416	$601,056	$1,068,001
Gross income	$6,965,105	$6,530,125	$184,229	$250,751
Income from sale of current[1]	$6,836,856	$6,413,878	$181,227	$241,751
Arc lighting, total[1]	$3,389,245	$3,213,711	$88,813	$86,721
Commercial or other private	$240,166	$219,179	$13,505	$7,482
Public[2]	$3,149,079	$2,994,532	$75,308	$79,239
Incandescent lighting, total	$3,359,618	$3,126,003	$89,733	$143,882
Commercial or other private	$2,868,296	$2,657,820	$81,964	$128,512
Public[2]	$491,322	$468,183	$7,769	$15,370
All other electric service	$87,993	$74,164	$2,681	$11,148
Income from all other sources	$128,249	$116,247	$3,002	$9,000
Total expenses[3]	$4,741,182	$4,466,711	$137,441	$137,030
Salaries and wages	$1,879,722	$1,768,404	$46,255	$65,063
Cost of supplies and materials	$852,901	$766,628	$48,219	$38,054
Cost of fuel	$1,445,824	$1,422,962	$22,341	$521
Rent of power	$123,566	$105,987	$5,980	$11,599
Rents, taxes, insurance, and miscellaneous expenses	$439,169	$402,730	$14,646	$21,793
Salaried officials, clerks, etc.:				
Number	950	881	19	50
Salaries	$457,381	$425,688	$11,161	$20,532
Wage-earners:				
Average number	2,467	2,325	55	87
Wages	$1,422,341	$1,342,716	$35,094	$44,531
Power plant equipment:[4]				
Steam and gas engines—				
Number	1,078	1,060	18	.....
Horsepower	147,975	144,851	3,124	.....
Water wheels—				
Number	82	.....	24	58
Horsepower	11,218	.....	2,088	9,130
Generating plant equipment:				
Dynamos—				
Number	1,822	1,701	41	80
Horsepower	151,984	141,369	3,900	6,715
Direct current, constant voltage—				
Number	418	395	7	16
Horsepower	23,533	22,524	439	570
Direct current, constant amperage—				
Number	582	543	19	20
Horsepower	37,763	35,948	1,183	632
Alternating and polyphase current—				
Number	822	763	15	44
Horsepower	90,688	82,897	2,278	5,513
Output of stations, kilowatt hours, total for year	195,904,439	177,281,083	8,674,893	9,948,463
Number of arc lamps	50,795	47,765	1,347	1,683
Number of incandescent lamps	1,577,451	1,433,023	55,906	88,522

[1] Includes estimated income from public lighting.
[2] Value estimated according to prevailing rates.
[3] Exclusive of interest on bonds amounting to $504,805.
[4] Does not include 36 auxiliary steam engines with a total capacity of 835 horsepower.

Of the 815 stations, costing $22,020,473, 768, costing $20,351,416, were operated by steam exclusively; 13, costing $601,056, employed both water and steam; while 34 depended upon water exclusively, their cost being $1,068,001. The earnings from the sale of current in these three classes were $6,413,878, $181,227, and $241,751, respectively. The other details of this table are of general interest, but need not be cited here.

The statistics of the group of exclusively waterpower stations, as developed in Table 42, are worthy of study.

TABLE 42.—CENTRAL ELECTRIC STATIONS OPERATED BY WATERPOWER EXCLUSIVELY, BY STATES: 1902.

	Total.	California.	New York.	Montana.	Washington.	Utah.	Michigan.	Maine.	All other states.[1]
Number of stations	312	29	37	9	9	10	35	20	163
Cost of construction and equipment	$38,289,439	$16,588,869	$3,925,234	$3,241,727	$1,992,155	$1,380,030	$1,117,891	$1,184,289	$8,859,244
Gross income	$4,134,416	$1,095,549	$529,838	$363,059	$353,031	$126,937	$242,416	$203,576	$1,220,010
Income from sale of current	$4,013,613	$1,082,888	$503,170	$359,620	$334,674	$126,937	$230,243	$191,552	$1,184,529
Arc lighting	$512,307	$42,338	$79,509	$14,715	$63,344	$1,626	$78,149	$37,919	$194,707
Incandescent lighting	$1,631,365	$273,594	$202,120	$74,299	$147,761	$31,366	$142,875	$124,233	$635,117
All other electric service	$1,869,941	$766,956	$221,541	$270,606	$123,569	$93,945	$9,219	$29,400	$354,705
Income from all other sources	$120,803	$12,661	$26,668	$8,439	$18,357	.....	$12,173	$12,024	$35,481
Salaried officials, clerks, etc.:									
Number	439	70	49	15	34	24	35	32	180
Salaries	$364,082	$95,314	$48,877	$25,651	$31,018	$18,745	$17,919	$16,258	$110,300
Wage-earners:									
Average number	1,263	248	324	54	55	44	84	77	377
Wages	$822,412	$208,377	$180,656	$50,433	$47,823	$24,278	$42,883	$43,587	$224,375
Water wheels:									
Number	612	91	66	30	35	15	57	34	284
Horsepower	217,261	61,904	35,347	21,220	16,353	9,410	7,940	7,241	57,846
Dynamos:									
Number	750	81	101	28	48	16	80	61	335
Horsepower	171,988	50,820	17,051	16,238	14,260	7,639	6,424	7,089	52,467
Output of stations, kilowatt hours, total for year	258,698,131	68,717,195	72,927,250	22,785,330	11,850,744	10,343,378	7,329,949	6,418,310	58,325,975
Number of arc lamps	9,060	572	1,383	196	1,087	39	1,635	878	3,270
Number of incandescent lamps	599,938	67,407	78,395	13,492	34,792	11,056	77,280	56,005	261,511

[1] Includes stations distributed as follows: Arkansas, 1; Colorado, 4; Connecticut, 6; Georgia, 6; Idaho, 5; Illinois, 3; Indiana, 1; Iowa, 2; Kansas, 3; Kentucky, 1; Massachusetts, 5; Minnesota, 6; Nebraska, 8; Nevada, 2; New Hampshire, 17; New Jersey, 4; New Mexico, 1; North Carolina, 7; Ohio, 3; Oregon, 10; Pennsylvania, 7; South Carolina, 1; South Dakota, 3; Tennessee, 4; Texas, 4; Vermont, 16; Virginia, 7; West Virginia, 1; Wisconsin, 24; Wyoming, 1.

In this table 312 private and municipal stations are dealt with collectively. It will be seen that 149, or nearly one-half, of these plants were in seven states, namely, New York, Michigan, California, Maine, Utah, Montana, and Washington, leaving 163 distributed among the other states. The total cost of construction and equipment for these 312 stations was reported as $38,289,439, or an average of $122,723 per station. For these stations the income from the sale of current was $4,013,613, and that from all other sources was $120,803. It is rather interesting to note that nearly one-half of the income was derived from all other electric service.

It is interesting to note also the cost of power plant equipment as related to motive power. As given in Table 1, the total horsepower capacity of all classes of prime movers, excluding possible "auxiliaries," in central stations, was 1,818,413 horsepower. The cost of construction and equipment was $504,740,352. This would give a cost of slightly over $278 per horsepower. It is instructive to compare this with the figures for stations using waterpower exclusively, which show an average of $176 per horsepower. It is not possible to arrive at an exact determination of all the steam plants as compared with all the water plants, for the reason that a considerable number of stations employ both steam and water, and the extent to which each power is used in the composite stations is not shown in the tables. It is fair, however, to infer from the statistics just given that it has been found economical and profitable to install the waterpower plants, and that where waterpower is available in an engineering sense it is a matter of business prudence to utilize it. As a matter of fact, the average cost of construction and equipment per horsepower in some of the plants using both steam and water power is relatively high, for the reason that the steam equipment has not been put in to assist in carrying a part of the load regularly, but because in seasons of drought or periods of low water the steam plant has been an absolute necessity as a safeguard against shutting down the station and leaving the customers without current. To this extent the economic value of waterpower for central station work is vitiated, for the success of such enterprises depends vitally upon a steady and uninterrupted supply of current, whether the station operates only during the hours of darkness or undertakes also to supply the wants of a locality as to current for traction, motive power for factories, and other general utilitarian purposes.

The average cost of construction and equipment of both private and municipal stations is shown in the following statement, classified according to the different kinds of power used:

Average cost of stations, classified according to motive power used: 1902.

MOTIVE POWER.	Private stations.	Municipal stations.
Total	$172,093	$27,019
Steam exclusively	146,661	26,499
Steam and water combined	383,641	46,235
Water exclusively	133,890	31,412

This statement shows that while the average cost of construction and equipment of private stations using steampower or waterpower exclusively was $146,661 and $133,890, respectively, those using both kinds of power averaged more than twice the amount for either of the others. The averages for the municipal stations show the same tendency, but in a less striking degree.

In connection with the financial statistics of waterpower stations, a few further interesting figures are derived from Table 42. It would appear from Table 1 that the output per horsepower of power plant equipment of all the central stations, regardless of the nature of power and of the ownership, was 1,378 kilowatt hours. Table 42, giving waterpower exclusively, shows an output of 1,190 kilowatt hours per horsepower of water wheel equipment. Moreover, the earnings per horsepower of power plant equipment of all stations were $45 per year, while the earnings of exclusively waterpower stations were only $18 per year. This is at the rate of 3.3 cents per kilowatt hour for all stations and only 1.5 cents per kilowatt hour for waterpower plants, considered separately. The higher cost of construction for steam plants, as well as their higher rate of earnings, is naturally explained to a large extent by the fact that they are installed under heavy expense in cities and busy centers of population, where land, labor, etc., cost more, whereas the waterpower plants are almost invariably more or less remote from urban districts and the large mass of consumers. But while the earnings per horsepower of $18 for waterpower plants may seem small, as compared with $55 for steam plants, it does not follow that the business of one group is on a less profitable basis than that of the other. The difference in the earnings per kilowatt hour indicates the ability of the waterpower plants to operate on a much lower basis of earnings than that required by the fuel consuming steampower, because, after the plants have once been installed, electric energy can be produced more economically by the waterpower plants.

Income in the leading cities.—In connection with the subject of income, the most interesting information is that connected with the large cities. It is in these cities, necessarily, that the electric lighting industry has attained its greatest development, the industry being one

which, during the earlier period of development, has been restricted to urban areas, as distinguished from rural. The small town or village has few streets that require elaborate or protracted illumination. The simpler habits of the people have limited the number of hours of darkness when light is required, and there are very few industries in which current for electric motors could be applied. Of late years the adoption of alternating current has greatly changed the conditions, so that even while the community may not deem it necessary to illumine its main thoroughfares properly, it is by no means unusual to find the electric light in modest cottages and scattered farmhouses, while the electric motor is being applied to agricultural work and to a variety of industries other than those of a manufacturing character. In addition to Table 6, which has already been discussed and which presents the general statistics, including capitalization and other items for New York, Chicago, St. Louis, Boston, Philadelphia, and Baltimore, comprising 30 stations, the extent to which the importance and success of the electric light and power industry is based upon the patronage extended to it in the principal cities is shown in the following table, which gives the per capita income, power and generating capacity, output of current, and the number of arc and incandescent lamps for 21 of the leading cities of the country. In order to avoid disclosing the operations of individual stations, several cities have been combined in showing the statistics in the table.

TABLE 43.—*Per capita income, power and generating capacity, output of current, and the number of arc and incandescent lamps of central stations, for selected cities: 1902.*

CITY.	Population.	PER CAPITA.					
		Income from sale of current.	Horsepower capacity of power plant.	Horsepower capacity of generating plant.	Output of current (kilowatt hours).	Number of arc lamps.	Number of incandescent lamps.
Total	11,892,177	$2.66	0.038	0.033	52.61	0.012	0.568
New York	3,437,202	2.86	0.033	0.022	44.60	0.008	0.748
Chicago	1,698,575	2.09	0.028	0.029	39.73	0.011	0.421
St. Louis	575,238	2.20	0.037	0.037	49.68	0.013	0.595
Boston	560,892	3.80	0.059	0.061	92.78	0.017	0.910
Cleveland	381,768	1.62	0.036	0.025	41.40	0.010	0.303
Buffalo	352,387	2.76	0.004	0.018	32.31	0.012	0.226
San Francisco	342,782	4.51	0.143	0.128	160.59	0.021	0.930
Louisville	204,731	2.31	0.045	0.049	72.99	0.012	0.283
Indianapolis	169,164	1.94	0.035	0.034	59.44	0.015	1.533
Rochester	162,608	5.11	0.139	0.089	159.66	0.032	0.584
Cincinnati and Detroit	611,606	2.48	0.044	0.042	56.21	0.019	0.565
Philadelphia, Pittsburg, and Providence	1,790,910	3.02	0.038	0.034	54.03	0.014	0.491
Baltimore, Washington, and New Orleans	1,074,779	1.87	0.027	0.026	36.56	0.009	0.278
Minneapolis, St. Paul, and Kansas City	529,535	2.08	0.026	0.021	38.92	0.013	0.316

According to the census of 1900 the population in these cities ranged from 3,437,202 in New York to 162,608 in Rochester, the total being 11,892,177. As already pointed out, many of the stations serve some population outside the corporate limits of the places in which they are located, but for the larger cities it is believed that the number is not sufficiently large to substantially vitiate the average. The average income per capita of these cities was $2.66. The variations above and below this amount are great, the extremes being $5.11 for Rochester and $1.62 for Cleveland. The high average in Rochester is undoubtedly attributable in large measure to the extensive and cheap utilization of the Genesee Falls waterpower by central stations in that city. High averages per capita are also shown for San Francisco and Boston, for which cities the figures are $4.51 and $3.80, respectively. The average for Philadelphia, Pittsburg, and Providence was $3.02, being considerably higher than the averages for all the cities. It would be impossible, without probing very deeply, to find explanations for the variations here brought to light, but, generally speaking, this table should be stimulating to the energies of the local station in places where the per capita consumption falls as low as it does in many instances.

If Buffalo be excepted, the horsepower capacity of power plant per capita ranges from 0.026 horsepower in Minneapolis, St. Paul, and Kansas City to 0.139 for Rochester and 0.143 for San Francisco. The averages for New York, St. Louis, Cleveland, Indianapolis, and the group of Philadelphia, Pittsburg, and Providence approximate the average for all the cities. The generating capacity per capita ranges from as low as 0.018 horsepower in Buffalo to as high as 0.128 horsepower in San Francisco; other high averages are 0.089 for Rochester and 0.061 for Boston.

It will be seen that in New York city, Chicago, Philadelphia, Baltimore, Cleveland, New Orleans, Minneapolis, St. Paul, and Kansas City the per capita is in the vicinity of 0.025 horsepower.

The kilowatt hour output depends somewhat on the productive capacity of the plants, although in view of what has been said it will be understood that a company can have an output of current all of which it does not generate, while, on the other hand, unless the population actually served is taken into consideration, the apparent consumption per capita—which is the equivalent of output—would rise to abnormal proportions. Thus, in the city of Rochester, the per capita kilowatt hour output is given as 159.66; in San Francisco, 160.59. A glance at the table will show that these are far above the average. For example, the per capita in New York is 44.60 kilowatt hours, and, disregarding

the decimals, runs as follows in other cities: 92 in Boston, 89 in Pittsburg, 72 in Louisville, 66 in Cincinnati, 54 in Washington, and 59 in Indianapolis.

Lamps per capita and income.—The columns as to proportion of lamps per capita have their bearing on the question of income, and that group may be here noted. The figures for *incandescent* lamps per capita are subject to possible correction, as discussed on page 77, but as shown in Table 43 the highest ratio is reached, apparently, in Indianapolis, of 1.533. None of the other cities come anywhere near this, the per capita being: For Boston, 0.910; San Francisco, 0.930; Providence, 0.906; Pittsburg, 0.871; New York city, 0.748; Detroit, 0.677; and St. Louis, 0.595. In Baltimore the per capita of incandescent lamps falls as low as 0.147. In Buffalo it is 0.226; in Minneapolis, 0.247; and in St. Paul, 0.295. In order to get a true idea of the real use per capita it would be necessary to include all lamps connected to isolated plants, which in some cities are very numerous. While Rochester is so abnormally high as to kilowatt hour output, it has a per capita of only 0.584, or slightly less than St. Louis, where the kilowatt output, on the other hand, was barely over 25 per cent of that of Rochester—an indication that a large proportion of current sold and earnings from operation in the latter place were due to motor service.

The per capita of *arc* lighting for all the cities runs with fair uniformity, and, as will be seen, the ratio falls off as they increase in size. Thus the per capita in Rochester of 0.032 at one end of the column decreases until it becomes 0.008 in New York at the other end of the column, although it falls slightly lower than that in Washington, namely, 0.007, and is closely approximated by Baltimore, where it is 0.009. In New York city, as in many of the large cities, a considerable proportion of the streets were and still are lighted by gas lamps, and in like manner a large proportion of the commercial lighting consists of incandescent lamps. The geographical location of the various cities would not appear to have much bearing upon the relative per capita under any of the heads, although none of the highest averages are reached by cities in the Southern and South Central divisions.

V.

EXPENSES.

General analysis of expenses.—The general figures of expense have already been noted in Section III of this chapter in connection with the general figures of income, Tables 14 and 15 giving the principal items and the percentages that they form of the total. The expenses of private and municipal stations reached a total of $68,081,375, of which $62,835,388, or 92.3 per cent, was for private stations and the remaining $5,245,987, or 7.7 per cent, for municipal stations. These expenses were classified into four main divisions, namely, salaries and wages, amounting to $20,646,692; cost of supplies, materials, and fuel, $22,915,932; rents, taxes, insurance, and miscellaneous expenses, $11,895,206; and interest on bonds, $12,623,545. Salaries and wages will be considered in Chapter IV, under "employees, salaries, and wages." The other items will be taken up and discussed in detail.

Cost of supplies and materials.—The central station expenses classified under the head of supplies, materials, and fuel, cover a wide field, including apparatus from which indefinitely long service may be expected, materials consumed from day to day, supplies that ultimately enter into construction and become permanent parts of the physical equipment, cost of purchased power, freight, and a number of other items. Tables 70 and 80 present analyses by states for private and municipal stations, respectively, showing the number and cost of meters, motors, transformers, incandescent lamps, carbons, arc lamp globes, and various other supplies purchased for use during the year. In gathering the statistics the actual cost of all supplies and materials exclusive of freight charges was requested, and the amount paid for freight, if any, was given as a separate item, but where it was not practicable to furnish this information separately the cost including freight charges was reported. The totals, therefore, are a combination of the central station reports in some of which the cost included freight while in others it did not, as a result of the different methods of bookkeeping in use in the various stations.

While it was the endeavor of the Bureau of the Census to eliminate from the cost of supplies and materials expenses for permanent additions to stations, such as new machinery, and for additions to the exterior equipment and lines on which new meters, motors, transformers, or lamps had been installed during the year, it is evident that in some cases a portion of supplies reported should have been charged as additions to the physical property of the station. Meters, motors, transformers, poles, wires, and cables have, under normal conditions, several years of life, and hence should be regarded as part of the central station investment represented by the capitalization, and as offsetting a certain amount of depreciation. Carbons, which are used from day to day, arc lamp globes, which are frequently smashed accidentally or maliciously, mill supplies needed daily in a power plant, and incandescent lamps requiring renewal once or twice a year, are items of consumption rather than of construction. On the other hand, some stations did an amount of mercantile business "over the counter" in the purchase and sale of incandescent lamps, arc lamps, carbons, etc., and although there is less tendency in this direction than there was in the early days of the industry, the greater extent of the field covered and the increased number of stations is likely to make such business considerable in the aggregate. It was, however, impossible to eliminate these items from the supplies used in operating

the system, or rather to distinguish the amount of profit over and above what the same material would have cost the station had the apparatus and supplies been used by the management rather than sold. The meters shown were required for measuring current on new circuits or were made necessary by the pronounced movement among central stations toward putting the sale of current on a scientific measuring basis in place of the old wasteful flat rate. Many of the motors enumerated would go directly into the central station equipment to serve in the operation of auxiliary mechanism. The transformers, like the meters, would be required for the extension of the lighting system.

Table 44 summarizes the totals for the cost of supplies and materials and shows the percentages which the amounts reported for the two classes of private and municipal stations were of the total. Although the table includes power purchased, it does not include the expense for fuel, this being treated as a separate subject.

TABLE 44.—*Cost of supplies and materials—private and municipal stations, and percentage each class is of total: 1902.*

	Total.	Private stations.	Municipal stations.	PER CENT— In private stations.	PER CENT— In municipal stations.
Total cost	$11,280,423	$10,303,956	$976,467	91.3	8.7
Meters:					
Number	27,632	25,739	1,893	93.1	6.9
Cost	$416,994	$390,569	$26,425	93.7	6.3
Motors:					
Number	602	572	30	95.0	5.0
Cost	$30,099	$29,202	$897	97.0	3.0
Transformers:					
Number	13,288	7,843	5,445	59.0	41.0
Cost	$365,028	$326,407	$38,621	89.4	10.6
Incandescent lamps:					
Number	8,839,905	8,399,571	440,334	95.0	5.0
Cost	$1,507,249	$1,426,224	$81,025	94.6	5.4
Incandescent lamp fittings, sockets, etc., cost	$177,236	$154,517	$22,719	87.2	12.8
Carbons for arc lamps:					
Number	94,686,596	82,156,930	12,529,666	86.8	13.2
Cost	$1,051,386	$900,788	$150,598	85.7	14.3
Globes for arc lamps:					
Number	485,073	428,979	56,094	88.4	11.6
Cost	$170,929	$150,509	$20,420	88.1	11.9
Arc lamp repairs, cost	$244,537	$212,231	$32,306	86.8	13.2
Poles or other supports, cost	$346,587	$319,617	$26,970	92.2	7.8
Wire and cable, cost	$1,152,915	$1,081,380	$71,535	93.8	6.2
Mill supplies (oil, waste, etc.), cost	$712,797	$617,911	$94,886	86.7	13.3
Power purchased, cost	$2,130,759	$2,007,193	$123,566	94.2	5.8
Freight paid, not included in other items	$1,120,363	$939,512	$180,851	83.9	16.1
All other materials, cost	$1,853,544	$1,747,896	$105,648	94.3	5.7

The total cost of all supplies and materials exclusive of fuel was $11,280,423; of this amount the stations under private ownership reported $10,303,956, or 91.3 per cent, and the stations under municipal control reported $976,467, or 8.7 per cent. The percentages in the subdivision of the apparatus varied considerably from these rates for reasons which can be readily understood in view of the different classes of business done. The work of the municipal plants is, as already noted, very largely arc street lighting, and hence the expenses for this class of supplies are proportionately high. For example, the expenses of municipal stations for arc carbons were $150,598, or 14.3 per cent of the total cost of such carbons, while the cost of globes for arc lamps was $20,420, or 11.9 per cent. The consumption of incandescent lamps fell to a low figure, the cost reported for municipal stations being $81,025, or only 5.4 per cent of the total. Somewhat strangely, however, the rate for incandescent lamp fittings was not less than 12.8 per cent, perhaps on account of street lighting, while the rate for transformers was 10.6 per cent. The purchase of the smaller types or sizes of transformers by municipal plants is strikingly brought out in the percentages of the number and the cost of such apparatus. Of the 13,288 reported, the municipal stations bought no fewer than 5,445, or 41 per cent and paid for them only $38,621, or 10.6 per cent. The small use of current for motor service in connection with municipal plants is again strikingly indicated by the fact that of the number of motors reported as bought the proportion was only 5 per cent, and the cost was only 3 per cent, of the total. Because of the nature of the service given, very few of the meters purchased were required by municipal plants, the number being only 6.9 per cent and the cost 6.3 per cent.

For the private stations reported in Table 44, out of a total of $10,303,956, the large amount of $2,007,193 was reported for power purchased, $1,426,224 for incandescent lamps, $900,788 for arc lighting carbons, $617,911 for mill supplies, $1,081,380 for wire and cable, and $939,512 for freight as a separate item, while miscellaneous materials were represented by the sum of $1,747,896.

It should be stated that the cost of hoods and miscellaneous supplies for arc lamps, amounting to $27,218, was included in the $1,853,544 reported as the cost of all other materials.

Cost of power purchased.—With respect to the large item of power purchased, it may be noted that a small number of central stations are engaged in the production of electric current for distribution to other stations, and are properly to be classed as distributing stations, although they also generate prime motive power to a limited extent for delivery without its conversion into electricity. The next report on electric light and power stations will undoubtedly include a large number of plants whose sole object is to generate current in large volume at waterpowers, coal mines, or oil fields, and transmit it long distances to distributing electric light plants or companies, which thus virtually will have become substations and will have ceased to manufacture current for themselves. Undoubtedly a number of such instances are included in this report, and hence the item of power purchased is larger than might reasonably have been expected. There were 136 stations thus reporting the purchase of electric current, costing $1,300,925. Another group of stations—71 in number—purchased waterpower costing $210,619, converting it themselves into current.

A third large group of 95 stations purchased steampower costing $296,831, and 1 station reported the purchase of power generated by gasoline engines at a cost of $240. There were 85 stations that rented the use of water for the operation of their water wheels, paying $322,144 for such hydraulic privileges, while the large aggregate sum of $460,011 was reported by a number of stations as paid for the water for generating steam in their boilers. Table 45 gives the percentage that the cost of each item of supplies and materials is of the total.

TABLE 45.—*Percentage that cost of each item of supplies and materials is of total—private and municipal stations: 1902.*

	Total.	Private stations.	Municipal stations.
Total	100.0	100.0	100.0
Meters	3.7	3.8	2.7
Motors	0.3	0.3	0.1
Transformers	3.2	3.2	4.0
Incandescent lamps	13.4	13.8	8.3
Incandescent lamp fittings, sockets, etc	1.6	1.5	2.3
Carbons for arc lamps	9.3	8.7	15.4
Globes for arc lamps	1.5	1.5	2.1
Arc lamp repairs	2.2	2.0	3.3
Poles or other supports	3.1	3.1	2.8
Wire and cable	10.2	10.5	7.3
Mill supplies (oil, waste, etc.)	6.3	6.0	9.7
Power purchased	18.9	19.5	12.7
Freight paid, not included in other items	9.9	9.1	18.5
All other materials	16.4	17.0	10.8

In private stations the cost of incandescent lamps formed 13.8 per cent of the total cost, and in municipal stations it was 8.3 per cent. On the other hand, the cost of carbons for arc lamps was 8.7 per cent in private stations and 15.4 in municipal stations. Power purchased in private stations reached the high proportion of 19.5 per cent, and was 12.7 per cent in municipal stations. Mill supplies in private stations were 6 per cent, and in municipal stations 9.7 per cent.

The analysis by states for these various items of supplies, materials, and power purchased does not call for particular comment. It is to be expected that a larger output would be attended by a larger consumption of material and supplies. The number and amounts follow closely the incomes from the sale of current reported for the respective states. New York figures as a large consumer in every class, followed by Pennsylvania, Massachusetts, Illinois, California, and Ohio.

Cost of fuel.—The item of fuel is a subdivision of one of the four main items of expense, namely, "cost of supplies, materials, and fuel," and constituted $11,635,509 out of the total of $22,915,932 included under that head. This total, however, is not the exact amount expended for coal and other fuel to be used in the generation of electric current, for an accurate separation of the expenditures was impossible. It has already been pointed out that the heading of supplies, materials, and fuel includes also power purchased at a cost of $2,130,759, of which steampower and gasoline power cost $297,071. This fuel account excludes also all allowance for current purchased by central stations for distribution, although much of that current was doubtless created by fuel consumption. As already shown in the tables presented, there were a large number of stations where both steam and water power were in use, and in these no attempt was made to charge up against the motive power plant the exact amount of current generated, so that the tables do not disclose for such plants how large a proportion of kilowatt hours was produced with the aid of steam and how large a proportion by means of waterpower. For these reasons a determination of the exact cost of fuel as related to the output would be very difficult.

Tables 70 and 80 present detailed statistics, by states and territories, for the different varieties of fuel reported by private and municipal stations, respectively.

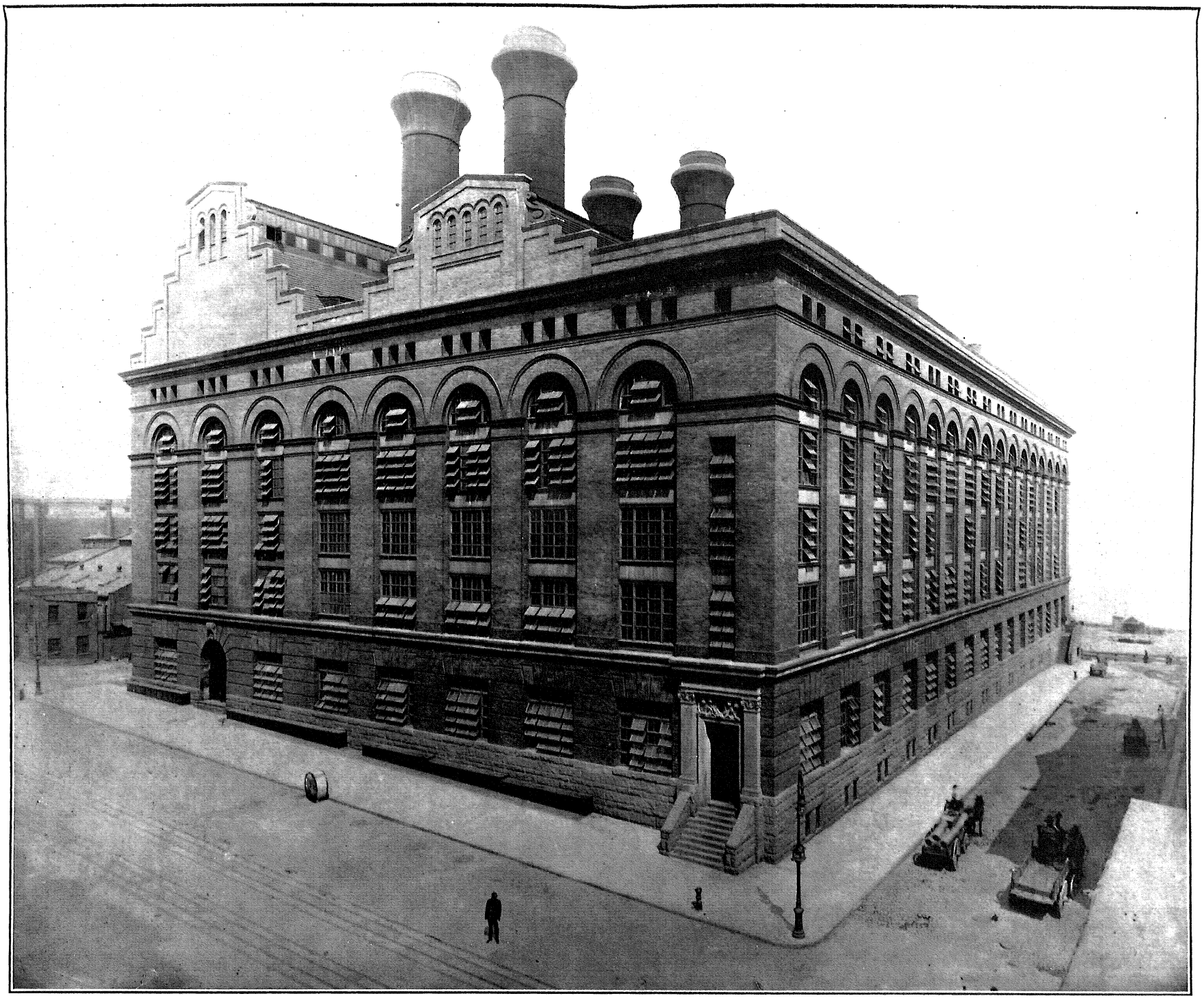
The totals are given in Table 46, which shows the percentage that the cost of the various kinds of fuel consumed in each class of stations forms of the totals for both classes.

TABLE 46.—*Cost of fuel—private and municipal stations, and percentage each class is of total: 1902.*

	Total.	PRIVATE STATIONS.		MUNICIPAL STATIONS.	
		Amount.	Per cent.	Amount.	Per cent.
Total	$11,635,509	$10,189,685	87.6	$1,445,824	12.4
Coal	9,943,125	8,749,394	88.0	1,193,731	12.0
Crude petroleum	721,838	700,136	97.0	21,702	3.0
Natural gas	254,269	220,460	86.7	33,809	13.3
Artificial gas	28,654	20,135	70.3	8,519	29.7
All other fuel	687,623	499,560	72.7	188,063	27.3

Coal was the fuel in most general use, its cost being $9,943,125, or 85.5 per cent of the total reported cost of fuel. All other fuels together amounted to 14.5 per cent. Next to coal, crude petroleum was the most important variety of fuel, its cost amounting to $721,838. In private stations the cost of this fuel formed 6.9 per cent of the total cost of all fuel purchased by those stations. Natural gas cost $254,269 and artificial gas $28,654. The large sum of $687,623 was expended for all other fuels, which would include a large amount of wood and lumber refuse as well as other waste materials.

The total amount of coal purchased was 4,249,137 tons at a cost of $8,749,394 for private stations, and 568,460 tons at a cost of $1,193,731 for municipal stations, the rates being $2.06 per ton for private stations and 4 cents more per ton for municipal stations. The difference in favor of private stations was undoubtedly due to the much larger quantities in which such fuel was purchased. The analysis by states naturally shows considerable variation in the cost of coal. This is due to the location of stations in states where coal is cheap and plentiful or their remoteness from the sources of supply; to the action of municipalities which in some cases forbid the use of the cheaper, more voluminous grades; to the fact that some stations use inferior grades, slack coal being purchased at a price as low as 60 cents a ton in Kansas; and to the different practices



EXTERIOR OF NEW YORK EDISON WATERSIDE STATION.

prevailing which result in some stations including freight in the cost while others do not. It will be seen, for example, that in California, where coal is scarce, 5,752 tons cost $28,365, or $4.93 per ton; but this amount probably includes the freight, as very little freight is reported for the state. The high price of coal would explain to some extent not only the enormous waterpower development in the state but also the fact that out of the total $700,136 expended in the country for crude petroleum for use under boilers in private central stations, $502,153 was reported in that state. The cost of coal is not always a determining factor where petroleum is concerned, for in the state of Texas, where coal costs about $1.63 per ton, its total cost was $170,691, while the expenditure for crude petroleum was not much less, being $124,365. In this state, however, the freight on coal was evidently reported separately, the report showing more freight paid in Texas than in any other state. Massachusetts is a state in which electric light and power has enjoyed remarkable development, but the prices of fuel there are seriously high. The 203,456 tons of coal necessary for the private stations were purchased at a cost of $808,361, or almost $4 per ton, but this again included the freight. In Illinois more than twice as much coal was purchased for a less amount, but here the freight was reported separately. In this state there was at one time a considerable consumption of natural gas for generating electric current, and crude petroleum also was extensively used for a time. In the census year, however, the expenditure for these fuels had dwindled to the insignificant amounts of $574 for petroleum and $3,473 for natural gas. With regard to the last-named fuel, Pennsylvania and Indiana furnished the largest items. The total for natural gas was $128,918 in Pennsylvania, $45,414 in Indiana, and $26,725 in Ohio. These three states accounted for $201,057 out of a total of $220,460. The low total for the whole country seems to be evidence of the diminishing importance of the natural gas fields, so far as the utility of gas for central stations is concerned.

As for crude petroleum, it will be noted that for the census year the consumption for private stations was limited almost entirely to two centers of production, California and Texas accounting for all but $73,618 out of a total of $700,136. A large amount, namely, $50,600, was reported from Arizona, and $15,866 from Louisiana. Only $204 was reported from Pennsylvania, but the quality of the petroleum produced in that state is such that it is used for illuminating purposes rather than for fuel.

Miscellaneous expenses.—Tables 72 and 82 present statistics for the principal items of miscellaneous expenses for the private and municipal stations, respectively, by states and territories. The totals are summarized in Table 47, which also shows the percentages that the amounts reported for private and municipal stations, respectively, are of the total.

TABLE 47.—*Miscellaneous expenses—private and municipal stations, and percentage each class is of total: 1902.*

	Total.	PRIVATE STATIONS.		MUNICIPAL STATIONS.	
		Amount.	Per cent.	Amount.	Per cent.
Total expenses	$11,895,206	$11,456,037	96.3	$439,169	3.7
Rent of stations, line wire supports and conduits, or underground privileges	1,011,691	1,001,504	99.0	10,187	1.0
Rent of offices	275,007	270,446	98.3	4,561	1.7
Taxes	2,665,005	2,654,885	99.6	10,120	0.4
Injuries and damages	248,304	246,545	99.3	1,759	0.7
Insurance	893,567	827,926	92.7	65,641	7.3
Ordinary repairs of buildings and machinery	2,701,747	2,480,217	91.8	221,530	8.2
Interest, advertising, office supplies, law expenses, telephone and telegraph service, and sundries	4,099,885	3,974,514	96.9	125,371	3.1

It will be seen that for all of the stations, rent, taxes, expenditure on account of injuries and damages, insurance, and cost of ordinary repairs account for $7,795,321, leaving the large amount of $4,099,885 for interest, law expenses, cost of advertising, office supplies, telephone and telegraph service, and sundries. This heterogeneous group constituted 34.5 per cent of all the miscellaneous expenses, while cost of repairs of buildings and machinery constituted only 22.7 per cent, and taxes 22.4 per cent. Of the total amount paid the private stations reported 96.3 per cent and the municipal stations only 3.7 per cent. The rent of stations, line wire supports, and conduits for municipal stations was only 1 per cent of the total cost of these items, and rent of offices was only 1.7 per cent of the total expended for office rent. In many instances the use of subways costs the municipalities nothing. The reservation, free of cost, of a certain number of ducts, as well as a certain pin or cross-arm capacity of pole line, is frequently part of the consideration for which certain ordinances or privileges are granted. The offices of the municipal departments are usually in some building that belongs to the municipality, and hence it rarely happens that a municipality has to pay rent to any large extent. Again, taxes for municipal stations fell to the low proportion of four-tenths of 1 per cent, from which it would appear that in few instances do the municipalities charge against themselves the entire amount of taxes that would have to be paid by stations under private ownership. The proportion paid for injuries and damages is also strikingly small for the municipal stations, being only seven-tenths of 1 per cent. The items of insurance and repairs for municipal plants are more nearly at the normal, being, respectively, 7.3 and 8.2 per cent. The amount reported for the group, including interest, etc., is only a small proportion of the whole—namely, 3.1 per cent. This is not surprising, however, because if there is any advertising account for a municipal station it is exceedingly small, while the interest on the floating debt is very small also, and telephone and telegraph service is often rendered free for ordinance considerations.

CHAPTER IV.

EMPLOYEES, SALARIES, AND WAGES.

Tables 71 and 81 show, by states and territories, the number of salaried officials and clerks and the total amount of salaries paid each class during the year, also the average number and total wages of the different classes of wage-earners in private and municipal stations, respectively. In accordance with the practice adopted for the investigation of manufactures,[1] the Bureau of the Census endeavored to secure the average number employed during the year because it would be the best indication of the force required to operate the stations continuously. In cases where a general account was kept covering two or more different services, such as the operation of waterworks or the manufacture of gas in addition to the production of electricity, and one employee, such as general manager, clerk, engineer, or fireman, worked indiscriminately for the different branches of the service, an estimate was made of the time and salary properly chargeable to the electric station, and only this proportion is included in the report.

I.

SALARIED OFFICIALS AND CLERKS.

General statistics.—There were 6,996 salaried officials and clerks employed by the central electric stations, and they were paid $5,663,580 in salaries. Of this number 43.1 per cent were clerks, who received 30.3 per cent of the total salaries. The stations operated under private ownership employed 86.4 per cent of the total number of officials and clerks, and those under municipal control 13.6 per cent. The salaries paid in the private stations amounted to 91.9 per cent, while those in the municipal stations amounted to 8.1 per cent of the total. The stations operated under private ownership gave employment to 91.3 per cent of the total number of clerks and paid 96.2 per cent of the total salaries paid to clerks as compared with 8.7 and 3.8 per cent, respectively, for municipal stations.

Statistics for private stations.—Of the 6,046 salaried officials and clerks reported by private stations, 1,416 were returned as general officers and 1,875 as other officers, such as managers and superintendents, and 2,755 as clerks. The total salaries paid to general officers was $1,465,471, to other officers $2,088,298, and the amount paid to clerks was $1,652,430. The rank of the states as to the number of salaried employees and their pay follows closely the rank as to earnings, and to some extent the rank as to the number of stations. Thus New York, with 228 stations and a gross income of $16,631,802, had 869 salaried employees to whom was paid $801,844; in Pennsylvania, with 243 stations and a gross income of $9,057,503, there were 667 employees with salaries amounting to $511,580; in Massachusetts, with 97 stations and a gross income of $6,070,643, the 420 salaried officials and clerks were paid $448,221; and in Illinois, with 264 stations and a gross income of $5,578,012, the number was 525, and the salaries amounted to $444,702. These larger totals show from two to four salaried employees per plant, a relation which exists also in several other states—for example, California, Missouri, New Jersey, and Ohio. But in many states the average number per plant was less. Thus in Arkansas, for 34 stations only 30 salaried officers and clerks were reported. In Florida 22 were employed for 21 stations; in Indian Territory, 7 for 10 stations; in Mississippi, 29 for 25 stations; in Nevada, 7 for 5 stations; in New Mexico, 12 for 11 stations; in North Dakota, 15 for 13 stations; in Oklahoma, 12 for 8 stations; in South Dakota, 18 for 22 stations; and in Wyoming, 13 for 13 stations. It will be readily seen that the average station in these states was not large enough to employ more than one man to look after the books and accounts, it being necessary for the one employee to divide his time in a manner that would enable the small station to operate most economically as to its expense for salary. As a matter of fact, however, many stations had no employees of this character, the work being done by the foremen or proprietors. Presumably the grade of salary would follow the industrial conditions of the section or community in which the station is located, but it would be governed also by the amount of work required.

If these figures be further analyzed it will be observed that both the general officers and the other officers were on a lower basis of compensation as compared with the clerks, although the combined executive and technical management of the station, as distinguished from the administration of officers, would appear to enjoy higher remuneration—a reasonable state of affairs wherever the responsibility for the technical operation of the station rested upon one man. These facts would be clearer if the difference between "general" officers and "managing" officers were more marked, but without going into very minute detail, it would be impossible to

[1] Twelfth Census, Vol. VII, page cvi.

extract and collate data with regard to all the actual conditions. In Oregon 5 general officers were paid $19,400, while 20 other officers were paid only $24,180. On the other hand, in Virginia, 18 general officers were paid $6,471, while 15 other officers were paid $8,674. In Idaho 4 general officers were paid $2,580, or $645 each, while 11 other officers were paid $13,520. Taking a larger state it will be seen that in New York 192 general officers were paid $261,465, while the other officers, 186 in number, were paid $237,106. In Pennsylvania, on the other hand, while 186 general officers were paid $118,564, or $637 each, 212 other officers were paid $233,140. Since in the number of stations New York and Pennsylvania did not differ much, the inference is that in Pennsylvania less of executive management was thrown upon the general officers, their duties being more purely financial, while the responsibility upon the manager and superintendent was heavier, and was accompanied by a correspondingly high salary. The subject is, however, a complicated one. The trained and educated electrical engineers devoting themselves to the central station industry professionally would be found very generally distributed throughout both groups of managers, and the extent to which the technical operation of the station would be preferred to the more general executive control of the enterprise, as a whole, would depend in almost every case upon personal predilection or idiosyncrasy.

Statistics for municipal stations.—As presented in Table 81, dealing with municipal stations, the number of salaried officers and clerks was 950, and their salaries amounted to $457,381. There were 171 general officers with salaries amounting to $36,051, 518 other officers with salaries amounting to $356,929, and 261 clerks with salaries amounting to $64,401. It will be seen that very few of the stations had general officers, and that even if the other officers were added to the general officers there would not be an average of one officer per plant. This is a striking indication of the economical basis upon which the stations were conducted, and the general absence from them of skill and training of high grade. This is partly due to the fact that such stations are frequently operated under a board of unpaid officials, virtually a committee of the local council or board of aldermen, and in some cases the salary reported was merely an estimated pro rata of that paid for the supervision of more than one service. This fact is more clearly illustrated by the much higher salaries paid to the other officers, managers, and superintendents. It is obvious, however, that the inducements presented to the mechanical or electrical engineer by the opportunities in the municipal electric lighting field, from the standpoint of salary, were far below those in the private field, unless the municipal officer could supplement his income quite substantially by the performance of kindred services for the community, or could do work outside his regular employment. Of course, there were some stations with salaries greater than the figure cited; for example, in Louisiana 6 general officers were paid $5,680. The few high salaries were offset by some very low figures; in Missouri, 3 general officers were paid $150; in Tennessee, 9 were paid $486; and in Wisconsin 3 were paid $225. In these and other instances the amount paid should probably be regarded as an honorarium rather than a salary. In like manner, in Illinois, 38 miscellaneous officers were paid $31,009; in Mississippi 9 were paid $8,668, while the rates for the solitary managers in Maine, Rhode Island, Montana, and Utah were, respectively, $832, $840, $900, and $960.

II.

WAGE-EARNERS.

General statistics.—Table 48 summarizes the totals for the average number and the wages of wage-earners reported for both private and municipal stations and shows the proportion in each class of station.

TABLE 48.—*Average number of wage-earners and total wages—private and municipal stations, and percentage each class is of total: 1902.*

OCCUPATION.	Total.	Private stations.	Municipal stations.	PER CENT— In private stations.	PER CENT— In municipal stations.
Total:					
Average number	23,330	20,863	2,467	89.4	10.6
Wages	$14,983,112	$13,560,771	$1,422,341	90.5	9.5
Foremen—					
Average number	1,000	943	57	94.3	5.7
Wages	$953,738	$910,972	$42,766	95.5	4.5
Inspectors—					
Average number	571	546	25	95.6	4.4
Wages	$415,904	$397,983	$17,921	95.7	4.3
Engineers—					
Average number	4,587	3,743	844	81.6	18.4
Wages	$3,259,870	$2,721,127	$538,743	83.5	16.5
Firemen—					
Average number	3,456	2,951	505	85.4	14.6
Wages	$1,963,465	$1,717,149	$246,316	87.5	12.5
Dynamo and switchboard men—					
Average number	1,978	1,872	106	94.6	5.4
Wages	$1,351,676	$1,286,065	$65,611	95.1	4.9
Linemen—					
Average number	4,217	3,868	349	91.7	8.3
Wages	$2,710,841	$2,510,269	$200,572	92.6	7.4
Mechanics—					
Average number	1,057	1,009	48	95.5	4.5
Wages	$796,355	$768,694	$27,661	96.5	3.5
Lamp trimmers—					
Average number	2,637	2,318	319	87.9	12.1
Wages	$1,654,462	$1,460,046	$194,416	88.2	11.8
All other employees—					
Average number	3,827	3,613	214	94.4	5.6
Wages	$1,876,801	$1,788,466	$88,335	95.3	4.7

The average number of wage-earners in central stations was 23,330, and the amount paid in wages was $14,983,112. Of these wage-earners 20,863, or 89.4 per cent, were employed in private stations, and 2,467, or 10.6 per cent, were employed in municipal stations. To those in the private stations were paid wages amounting to $13,560,771, or 90.5 per cent of the total, and to those in municipal stations $1,422,341, or 9.5 per cent.

Classification of wage-earners according to occupation.—These wage-earners were divided into eight main classes and one miscellaneous class. The eight chief

groups include foremen, inspectors, engineers, firemen, dynamo and switchboard men, linemen, mechanics, and lamp trimmers, while the miscellaneous class includes a large proportion of unskilled labor.

The equipment, size of station, and character of the service control very largely the proportion that the different classes of wage-earners are of the total. For instance, an engineer may act as the fireman or possibly as the foreman of a small station, while in a large station the positions would be filled by separate employees. Small stations do not necessarily require inspectors, and the linework may be done by the general mechanics. In the same manner the duties of the linemen and the lamp trimmer may be combined in one person in small stations, while larger stations require separate employees for these positions; therefore, it is not always possible to make an accurate segregation of the employees according to occupation. With this explanation the following table is presented to show the proportion that the number of wage-earners reported for each of the 8 classes, is of the total for all stations and for private and municipal stations, respectively:

TABLE 49.—*Percentage that number of wage-earners reported for each occupation is of total—private and municipal stations: 1902.*

OCCUPATION.	Total.	Private stations.	Municipal stations.
All classes	100.0	100.0	100.0
Foremen	5.1	5.5	2.5
Inspectors	3.0	3.2	1.1
Engineers	23.5	21.7	37.5
Firemen	17.7	17.1	22.4
Dynamo and switchboard men	10.2	10.9	4.7
Linemen	21.6	22.4	15.5
Mechanics	5.4	5.8	2.1
Lamp trimmers	13.5	13.4	14.2

Accepting the totals for each occupation as the number required to discharge the duties in each case, the table shows to what extent the principal occupations, such as linemen, engineers, and firemen, predominate; also the variation in the proportion reported for each occupation in the two classes of stations. The greatest variation appears for engineers, who formed 21.6 per cent of all wage-earners in private stations and 37.3 per cent of all those in municipal stations. The predominance of engineers and firemen is more pronounced in the municipal stations, while the proportion for each of the other occupations, except lamp trimmers, is larger in the private stations.

It is probable that the duties of engineers, firemen, and dynamo and switchboard men are as intimately related as those of any of the occupations enumerated, and the relation between the numbers reported for the stations operated under private and municipal control is indicative of the extent to which separate employees were required for the different branches of work. In the private stations 1 fireman was required for every 1.3 engineers and 1 dynamo and switchboard man for every 2.3 engineers, while in the municipal stations the proportions were 1 to 1.7 and 1 to 8, respectively. In other words, the totals for all stations, large and small, indicate that in the municipal stations the engineers were more accustomed to perform a greater diversity of the duties incident to the operations of the power and generating plant than they were in the stations operated under private ownership. Continuing this comparison, it appears that in the private stations 1 foreman is required for every 17.3 of all other employees of the classes enumerated, and in the municipal stations the proportion is 1 to 38.5; but the great difference in these proportions can probably be accounted for by the fact that the supervision of a municipal station is frequently assigned to a public official who has other duties to perform, and the time devoted to the electric station is so limited that he is not considered as one of its employees, or the engineer may discharge the duties that would be assigned to a foreman in a station operated for private interests.

Statistics for private stations.—In Table 71 the wage-earners are presented, by states and territories, for the private stations. By far the largest number of wage-earners in private stations was found in New York, where 4,427 were employed, earning $3,035,971. Next came Pennsylvania, with 2,327, earning $1,468,472; Massachusetts, with 1,474, earning $1,053,344; Illinois, with 1,400, earning $871,165; Ohio, with 1,026, earning $636,515; and California, with 976, earning $758,678. The number of wage-earners per station averaged over 19 in New York as compared with not quite 10 in Pennsylvania, 15 in Massachusetts, 5 in Illinois, 7 in Ohio, and 9 in California.

The foremen were somewhat more generally distributed than the inspectors, there being 943 foremen and only 546 inspectors. Engineers numbered 3,743, or more than 1 per station. Their numbers generally followed the respective magnitude of stations and the extent to which the industry had been developed, but depended somewhat on the prevalence of the use of waterpower. In New York the number of engineers employed was 451 for the 228 stations as compared with 471 for the 243 stations in Pennsylvania. In Illinois there were 377 engineers in 264 stations and in California only 94 in 105 stations. In New York, California, and some other states, the extent to which waterpower was utilized obviously had an influence in determining the number of both the engineers and the firemen as related to the number of dynamo and switchboard men. Thus, regardless of the small number of

engineers and firemen, there were in California 194 dynamo and switchboard men, which was a more uniform ratio and a number in closer harmony with the figures for other states, where waterpower was not so generally used. The engineers and firemen in smaller stations were evidently employed upon the same class of work, as this table shows that where the number of engineers is relatively low the number of firemen is equally high and vice versa. It is to be noted that no firemen were employed in Nevada and that that state was also without linemen and mechanics, the duty of such employees being discharged by others. In like manner the stations in Indian Territory, New Mexico, North Dakota, and Oklahoma reported no dynamo tenders or switchboard men, the inference being that some of these unavoidable duties were performed by the lamp trimmers.

For the private stations in the United States there were reported 2,318 lamp trimmers and 334,903 arc lamps, the average being 144 lamps to each lamp trimmer. The introduction of the inclosed arcs, which require trimming only at intervals of several days, would lessen the amount of work here indicated, and the number of lamps per trimmer would be further reduced by the extent to which the work would be shared by linemen, of whom 3,868 were returned. Some of the lamp trimming also, as well as the other duties ascribed to the men in the various categories enumerated, would be performed by the "all other employees," numbered at 3,613. But this class would include a large number of minor wage-earners engaged in unskilled labor rather than in the skilled work necessary for the operation of an electric light plant. It will be noticed that in New York the number of lamp trimmers was 616 as compared with 708 linemen, while in Pennsylvania there were only 267 lamp trimmers as compared with 522 linemen; in Illinois, 179 as compared with 238; and in Massachusetts 145 as compared with 247.

In Pennsylvania only 224, or about 10 per cent, of the wage-earners were reported as in the group of "all other employees," but in New York 1,055, or over 23 per cent, and in Massachusetts 447, or 30 per cent, were thus classified. Large numbers in this group would indicate a wider variety of occupations than is possible in many of the smaller stations, where employees are almost entirely accounted for under the main classifications and distinctions given.

Statistics for municipal stations.—In Table 81 the wage-earners in municipal stations are subject to the same classifications as those in private stations, but show a much more general merging of functions as a result of the relatively lesser magnitude of the stations.

Of the 2,467 wage-earners in municipal stations, 359 were in Illinois, 290 in Michigan, 275 in Ohio, 172 in Indiana, 140 in Pennsylvania, and 127 in Minnesota. The average number of wage-earners for the municipal stations was about 3; in Florida, Washington, Texas, and Massachusetts the average was 5 or more; and in Oregon there were only 5 wage-earners to 6 stations. A cursory examination of the table will show from the numerous gaps how generally the various duties are concentrated in one person, rendering it difficult to make an exact classification under each head. Some of the municipal stations were without engineers and firemen, although this would be explained by the absence of steam engines and the use of waterpower, but in several states no dynamo or switchboard men were accounted for, no linemen, no mechanics, and no lamp trimmers.

III.

DAILY WAGES.

Specified daily rates of pay.—In addition to requiring the average number of wage-earners and the total amount of wages, the schedules called for the number of the different classes of wage-earners at specified daily rates of pay. In a number of cases, where the work of the central electric station was carried on in connection with some other industry, it was impossible to obtain satisfactory answers to this inquiry, but the returns for 3,197 stations were sufficiently complete for tabulation. For these stations Table 50 shows for all the wage-earners, except those classified as "all other employees" and for the leading classes separately the number receiving stated daily rates of wages within 25-cent limits. It shows also the percentage that the number falling within each wage group bears to the total number of wage-earners of the class, together with cumulative percentages.

TABLE 50.—NUMBER OF WAGE-EARNERS AT SPECIFIED DAILY RATES OF PAY, WITH PERCENTAGES OF TOTAL AND CUMULATIVE PERCENTAGES—PRIVATE AND MUNICIPAL STATIONS: 1902.

[Each cumulative percentage shows the proportion of total number of persons in the given class receiving a wage as great as, or greater than, the lowest wage of the given wage group.]

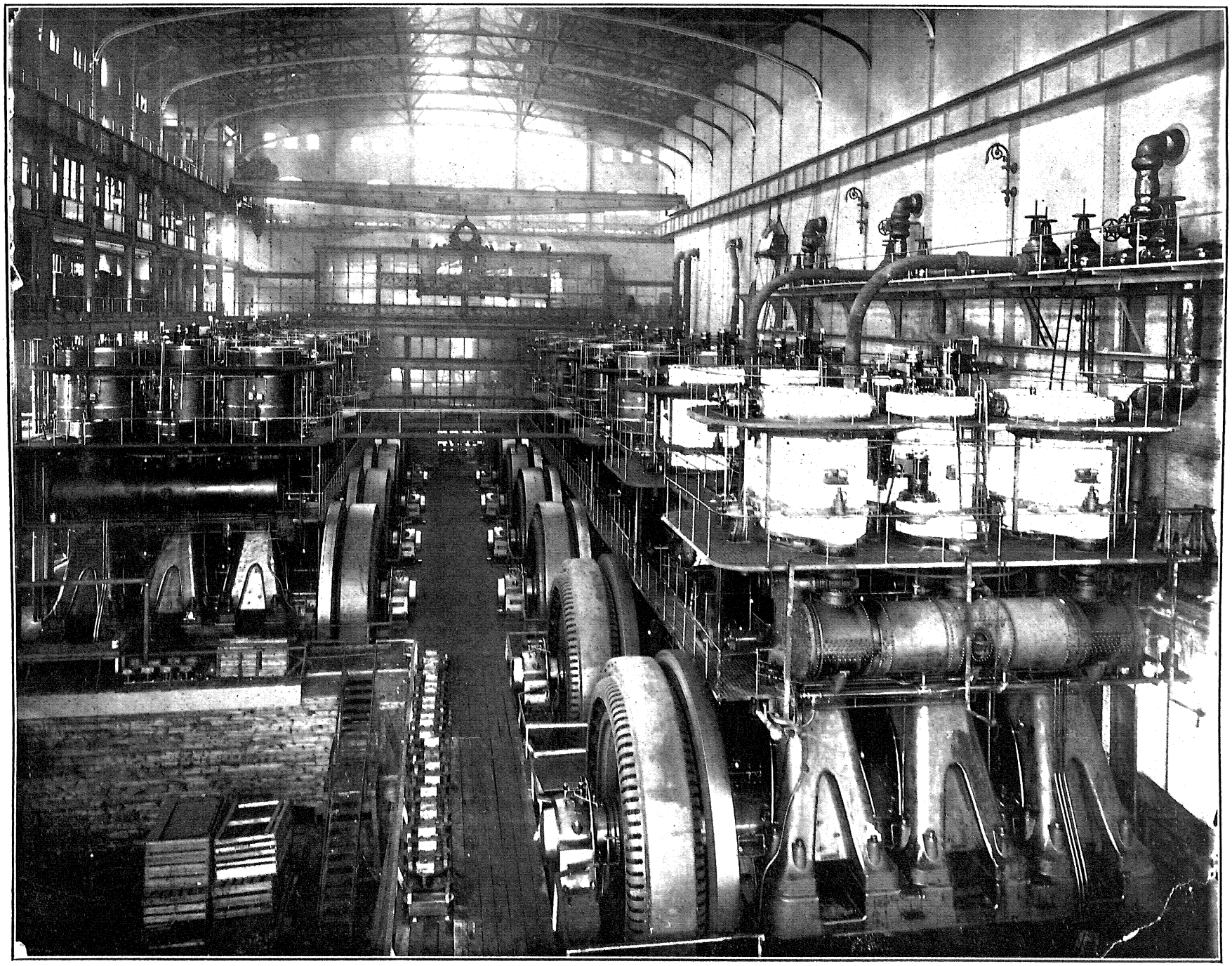
RATE PER DAY (DOLLARS).	ALL CLASSES.			FOREMEN.			INSPECTORS.			ENGINEERS.		
	Number.	Per cent. Of total.	Per cent. Cumulative.	Number.	Per cent. Of total.	Per cent. Cumulative.	Number.	Per cent. Of total.	Per cent. Cumulative.	Number.	Per cent. Of total.	Per cent. Cumulative.
Total	18,878	100.0	.....	958	100.0	.....	557	100.0	.....	4,409	100.0	.....
Less than 1.00	362	1.9	100.0	2	0.2	100.0	15	2.7	100.0	42	1.0	100.0
1.00 to 1.24	990	5.2	98.1	7	0.7	99.8	13	2.3	97.3	211	4.8	99.0
1.25 to 1.49	1,613	8.5	92.9	17	1.8	99.1	31	5.6	95.0	469	10.7	94.2
1.50 to 1.74	3,380	17.9	84.4	59	6.2	97.3	50	9.0	89.4	825	18.7	83.5
1.75 to 1.99	2,314	12.3	66.5	34	3.6	91.1	70	12.6	80.4	438	9.9	64.8
2.00 to 2.24	4,089	21.7	54.2	94	9.8	87.5	141	25.3	67.8	892	20.2	54.9
2.25 to 2.49	1,807	9.6	32.5	82	8.6	77.7	67	12.0	42.5	351	8.0	34.7
2.50 to 2.74	1,899	10.1	22.9	132	13.8	69.1	87	15.6	30.5	472	10.7	26.7
2.75 to 2.99	823	4.4	12.8	77	8.0	55.3	19	3.4	14.9	181	4.1	16.0
3.00 to 3.24	832	4.4	8.4	163	17.0	47.3	34	6.1	11.5	226	5.1	11.9
3.25 to 3.49	309	1.6	4.0	116	12.1	30.3	10	1.8	5.4	115	2.6	6.8
3.50 to 3.74	191	1.0	2.4	76	7.9	18.2	9	1.6	3.6	58	1.3	4.2
3.75 and over	269	1.4	1.4	99	10.3	10.3	11	2.0	2.0	129	2.9	2.9

RATE PER DAY (DOLLARS).	FIREMEN.			DYNAMO AND SWITCHBOARD MEN.			LINEMEN.			MECHANICS.			LAMP TRIMMERS.		
	Number.	Per cent. Of total.	Per cent. Cumulative.	Number.	Per cent. Of total.	Per cent. Cumulative.	Number.	Per cent. Of total.	Per cent. Cumulative.	Number.	Per cent. Of total.	Per cent. Cumulative.	Number.	Per cent. Of total.	Per cent. Cumulative.
Total	3,340	100.0	.....	1,888	100.0	.....	4,099	100.0	.....	1,039	100.0	.....	2,588	100.0	.....
Less than 1.00	150	4.5	100.0	22	1.2	100.0	57	1.4	100.0	9	0.9	100.0	65	2.5	100.0
1.00 to 1.24	334	10.0	95.5	105	5.6	98.8	179	4.4	98.6	7	0.7	99.1	134	5.2	97.5
1.25 to 1.49	472	14.1	85.5	138	7.3	93.2	265	6.4	94.2	19	1.8	98.4	202	7.8	92.3
1.50 to 1.74	740	22.2	71.4	348	18.4	85.9	686	16.7	87.8	107	10.3	96.6	565	21.8	84.5
1.75 to 1.99	472	14.1	49.2	263	13.9	67.5	520	12.7	71.1	164	15.8	86.3	353	13.7	62.7
2.00 to 2.24	587	17.6	35.1	423	22.4	53.6	835	20.4	58.4	276	26.6	70.5	841	32.5	49.0
2.25 to 2.49	295	8.8	17.5	264	14.0	31.2	331	8.1	38.0	101	9.7	43.9	316	12.2	16.5
2.50 to 2.74	128	3.8	8.7	180	9.5	17.2	668	16.3	29.9	161	15.5	34.2	71	2.8	4.3
2.75 to 2.99	122	3.6	4.9	56	3.0	7.7	278	6.8	13.6	71	6.8	18.7	19	0.7	1.5
3.00 to 3.24	33	1.0	1.3	56	3.0	4.7	225	5.5	6.8	85	8.2	11.9	10	0.4	0.8
3.25 to 3.49	3	0.1	0.3	20	1.0	1.7	25	0.6	1.3	14	1.3	3.7	6	0.2	0.4
3.50 to 3.74	2	0.1	0.2	4	0.2	0.7	23	0.5	0.7	13	1.3	2.4	6	0.2	0.2
3.75 and over	2	0.1	0.1	9	0.5	0.5	7	0.2	0.2	12	1.1	1.1	.....	.....	.....

In addition to the 8 classes of wage-earners shown in the table, other wage-earners were reported as engaged in a variety of occupations, too numerous to designate at specified rates of pay, and they were, therefore, omitted from this table, although they were included in Tables 71 and 81 under the group of "all other employees." This table, therefore, shows for the 8 classes of wage-earners in the 3,197 stations operated under private and municipal ownership, for which the employees are summarized by occupations at stated daily rates of pay, 18,878 wage-earners, or 80.9 per cent of the total number for all stations in operation during the year covered by this report. The distribution of this large number of employees among the different daily rates of pay indicates very closely the prevailing rates of wages in the industry. For all classes taken together the prevailing rate of wages was from $1.50 to $2.24 per day, 9,783 wage-earners, or 51.8 per cent of the total number shown in the table, being paid at this rate. It appears that 13,489 wage-earners, or more than two-thirds of the total number, received from $1.50 to $2.74 per day. More than one-half of the engineers received from $1.50 to $2.49 per day, and more than one-half of the firemen received from $1.50 to $2.24 per day.

The cumulative percentages in the table indicate the proportion of the total number of wage-earners of the different occupations who received not less than the lowest rate of the given wage group. Thus, for all wage-earners combined, the cumulative percentage opposite the group of $1.75 to $1.99 per day indicates that 66.5 per cent of the total number received $1.75 or more per day. The percentage of total opposite the same wage group indicates that 12.3 per cent of all wage-earners received between $1.75 and $1.99, thus leaving 54.2 per cent who received more than $1.99, which is the cumulative percentage for the next higher wage group.

All but 330 of the 2,805 stations operated under private ownership, and all but 93 of the 815 stations operated under municipal control, gave satisfactory replies to the inquiry concerning the number of employees at stated daily rates of pay, and the results are shown in the following tables:



INTERIOR OF NEW YORK EDISON WATERSIDE STATION.

This plant exemplifies on a large scale the largest development of direct connected dynamos and engines as separate mechanism, the engines being of the reciprocating type.

TABLE 51.—NUMBER OF WAGE-EARNERS AT SPECIFIED DAILY RATES OF PAY, WITH PERCENTAGES OF TOTAL AND CUMULATIVE PERCENTAGES—PRIVATE STATIONS: 1902.

[Each cumulative percentage shows the proportion of total number of persons in the given class receiving a wage as great as, or greater than, the lowest wage of the given wage group.]

RATE PER DAY (DOLLARS).	ALL CLASSES.			FOREMEN.			INSPECTORS.			ENGINEERS.		
	Number.	Per cent.		Number.	Per cent.		Number.	Per cent.		Number.	Per cent.	
		Of total.	Cumulative.		Of total.	Cumulative.		Of total.	Cumulative.		Of total.	Cumulative.
Total	16,721	100.0	.....	908	100.0	.....	533	100.0	.....	3,604	100.0	.....
Less than 1.00	257	1.5	100.0	2	0.2	100.0	14	2.6	100.0	34	1.0	100.0
1.00 to 1.24	789	4.7	98.5	6	0.7	99.8	13	2.4	97.4	152	4.2	99.0
1.25 to 1.49	1,319	7.9	93.8	13	1.4	99.1	31	5.8	95.0	365	10.1	94.8
1.50 to 1.74	2,940	17.6	85.9	52	5.7	97.7	50	9.4	89.2	657	18.2	84.7
1.75 to 1.99	2,081	12.4	68.3	33	3.6	92.0	66	12.4	79.8	354	9.8	66.5
2.00 to 2.24	3,671	21.9	55.9	89	9.8	88.4	134	25.1	67.4	724	20.1	56.7
2.25 to 2.49	1,604	9.6	34.0	75	8.3	78.6	62	11.6	42.3	286	8.0	36.6
2.50 to 2.74	1,733	10.4	24.4	120	13.2	70.3	82	15.4	30.7	382	10.6	28.6
2.75 to 2.99	794	4.8	14.0	74	8.2	57.1	19	3.6	15.3	166	4.6	18.0
3.00 to 3.24	798	4.8	9.2	158	17.4	48.9	33	6.2	11.7	203	5.6	13.4
3.25 to 3.49	284	1.7	4.4	113	12.4	31.5	10	1.9	5.5	97	2.7	7.8
3.50 to 3.74	189	1.1	2.7	76	8.4	19.1	9	1.7	3.6	58	1.6	5.1
3.75 and over	262	1.6	1.6	97	10.7	10.7	10	1.9	1.9	126	3.5	3.5

RATE PER DAY (DOLLARS).	FIREMEN.			DYNAMO AND SWITCHBOARD MEN.			LINEMEN.			MECHANICS.			LAMP TRIMMERS.		
	Number.	Per cent.		Number.	Per cent.		Number.	Per cent.		Number.	Per cent.		Number.	Per cent.	
		Of total.	Cumulative.		Of total.	Cumulative.		Of total.	Cumulative.		Of total.	Cumulative.		Of total.	Cumulative.
Total	2,854	100.0	.....	1,787	100.0	.....	3,760	100.0	.....	993	100.0	.....	2,282	100.0	.....
Less than 1.00	99	3.5	100.0	19	1.1	100.0	40	1.1	100.0	8	0.8	100.0	41	1.8	100.0
1.00 to 1.24	261	9.1	96.5	96	5.4	98.9	146	3.9	98.9	5	0.5	99.2	110	4.8	98.2
1.25 to 1.49	364	12.8	87.4	126	7.1	93.5	228	6.1	95.0	15	1.5	98.7	177	7.7	93.4
1.50 to 1.74	623	21.8	74.6	328	18.4	86.4	620	16.5	88.9	104	10.5	97.2	506	22.2	85.7
1.75 to 1.99	418	14.6	52.8	245	13.7	68.0	480	12.8	72.4	161	16.2	86.7	324	14.2	63.5
2.00 to 2.24	513	18.0	38.2	407	22.8	54.3	772	20.5	59.6	268	27.0	70.5	764	33.5	49.3
2.25 to 2.49	287	10.0	20.2	251	14.0	31.5	303	8.0	39.1	87	8.8	43.5	253	11.1	15.8
2.50 to 2.74	128	4.5	10.2	176	9.8	17.5	621	16.5	31.1	156	15.7	34.7	68	3.0	4.7
2.75 to 2.99	122	4.3	5.7	54	3.0	7.7	275	7.3	14.6	67	6.7	19.0	17	0.7	1.7
3.00 to 3.24	32	1.1	1.4	52	2.9	4.7	225	6.0	7.3	85	8.6	12.3	10	0.4	1.0
3.25 to 3.49	3	0.1	0.3	20	1.1	1.8	23	0.6	1.3	12	1.2	3.7	6	0.3	0.6
3.50 to 3.74	2	0.1	0.2	4	0.2	0.7	21	0.5	0.7	13	1.3	2.5	6	0.3	0.3
3.75 and over	2	0.1	0.1	9	0.5	0.5	6	0.2	0.2	12	1.2	1.2	.....	.....	.....

TABLE 52.—NUMBER OF WAGE-EARNERS AT SPECIFIED DAILY RATES OF PAY, WITH PERCENTAGES OF TOTAL AND CUMULATIVE PERCENTAGES—MUNICIPAL STATIONS: 1902.

[Each cumulative percentage shows the proportion of total number of persons in the given class receiving a wage as great as, or greater than, the lowest wage of the given wage group.]

RATE PER DAY (DOLLARS).	ALL CLASSES.			FOREMEN.			INSPECTORS.			ENGINEERS.		
	Number.	Per cent.		Number.	Per cent.		Number.	Per cent.		Number.	Per cent.	
		Of total.	Cumulative.		Of total.	Cumulative.		Of total.	Cumulative.		Of total.	Cumulative.
Total	2,157	100.0	.....	50	100.0	.....	24	100.0	.....	805	100.0	.....
Less than 1.00	105	4.9	100.0	.....	.....	.....	1	4.2	100.0	8	1.0	100.0
1.00 to 1.24	201	9.3	95.1	1	2.0	100.0	.....	.....	95.8	59	7.3	99.0
1.25 to 1.49	294	13.6	85.8	4	8.0	98.0	.....	.....	95.8	104	12.9	91.7
1.50 to 1.74	440	20.4	72.2	7	14.0	90.0	.....	.....	95.8	168	20.9	78.8
1.75 to 1.99	233	10.8	51.8	1	2.0	76.0	4	16.7	95.8	84	10.4	57.9
2.00 to 2.24	418	19.4	41.0	5	10.0	74.0	7	29.1	79.1	168	20.9	47.5
2.25 to 2.49	203	9.4	21.6	7	14.0	64.0	5	20.8	50.0	65	8.1	26.6
2.50 to 2.74	166	7.7	12.2	12	24.0	50.0	5	20.8	29.2	90	11.2	18.5
2.75 to 2.99	29	1.3	4.5	3	6.0	26.0	.....	.....	8.4	15	1.9	7.3
3.00 to 3.24	34	1.6	3.2	5	10.0	20.0	1	4.2	8.4	23	2.8	5.4
3.25 to 3.49	25	1.2	1.6	3	6.0	10.0	.....	.....	4.2	18	2.2	2.6
3.50 to 3.74	2	0.1	0.4	.....	.....	4.0	.....	.....	4.2	.....	.....	0.4
3.75 and over	7	0.3	0.3	2	4.0	4.0	1	4.2	4.2	3	0.4	0.4

TABLE 52.—NUMBER OF WAGE-EARNERS AT SPECIFIED DAILY RATES OF PAY, WITH PERCENTAGES OF TOTAL AND CUMULATIVE PERCENTAGES—MUNICIPAL STATIONS: 1902—Continued.

[Each cumulative percentage shows the proportion of total number of persons in the given class receiving a wage as great as, or greater than, the lowest wage of the given wage group.]

RATE PER DAY (DOLLARS).	FIREMEN.			DYNAMO AND SWITCHBOARD MEN.			LINEMEN.			MECHANICS.			LAMP TRIMMERS.		
	Number.	Per cent. Of total.	Per cent. Cumulative.	Number.	Per cent. Of total.	Per cent. Cumulative.	Number.	Per cent. Of total.	Per cent. Cumulative.	Number.	Per cent. Of total.	Per cent. Cumulative.	Number.	Per cent. Of total.	Per cent. Cumulative.
Total	486	100.0	.....	101	100.0	.....	339	100.0	.....	46	100.0	.....	306	100.0	.....
Less than 1.00	51	10.5	100.0	3	3.0	100.0	17	5.0	100.0	1	2.1	100.0	24	7.8	100.0
1.00 to 1.24	73	15.0	89.5	9	8.9	97.0	33	9.7	95.0	2	4.4	97.9	24	7.8	92.2
1.25 to 1.49	108	22.2	74.5	12	11.9	88.1	37	10.9	85.3	4	8.7	93.5	25	8.2	84.4
1.50 to 1.74	117	24.1	52.3	20	19.8	76.2	66	19.5	74.4	3	6.5	84.8	59	19.3	76.2
1.75 to 1.99	54	11.1	28.2	18	17.8	56.4	40	11.8	54.9	3	6.5	78.3	29	9.5	56.9
2.00 to 2.24	74	15.2	17.1	16	15.8	38.6	63	18.6	43.1	8	17.4	71.8	77	25.2	47.4
2.25 to 2.49	8	1.7	1.9	13	12.8	22.8	28	8.3	24.5	14	30.4	54.4	63	20.6	22.2
2.50 to 2.74	.....	.....	0.2	4	4.0	10.0	47	13.8	16.2	5	10.9	24.0	3	1.0	1.6
2.75 to 2.99	.....	.....	0.2	2	2.0	6.0	3	0.9	2.4	4	8.7	13.1	2	0.6	0.6
3.00 to 3.24	1	0.2	0.2	4	4.0	4.0	.....	.....	1.5	.....	.....	4.4	.....	.....	.....
3.25 to 3.49	.....	.....	.....	.....	.....	.....	2	0.6	1.5	2	4.4	4.4	.....	.....	.....
3.50 to 3.74	.....	.....	.....	.....	.....	.....	2	0.6	0.9	.....	.....	.....	.....	.....	.....
3.75 and over	.....	.....	.....	.....	.....	.....	1	0.3	0.3	.....	.....	.....	.....	.....	.....

The equipment of a station, its size, and the character of its service necessarily govern the proportion of the different classes of wage-earners to the total. This feature has already been discussed, but it may be again pointed out that small stations do not necessarily require inspectors or foremen, and that the linework might be done by lamp trimmers or mechanics, while an engineer might act as foreman, and a dynamo tender, besides watching the switchboard, could fire the boiler and oil the engine. This merging of work is, in fact, so common as to render it difficult to make any closely accurate segregation of employees according to specified occupations. The rate of pay, however, in each of these cases, while subject to varying skilled labor conditions in the vicinity, is likely to be that of the higher class, in order to compensate properly for the variety of skill required and for the large amount of responsibility assumed. It stands to reason that a fireman performing the work of an engineer would be much more likely to consider and rate himself in the higher class than in the lower, even though his wages were not commensurate with the more exacting position.

Median rates of pay.—By a median rate of wages is meant the rate of the employee who stands halfway between the lowest paid and the highest paid employee in the class under consideration; in other words, an absolutely precise median would be a rate such that the number of employees receiving wages higher than the rate named is equal to the number receiving lower wages. For the purpose of permitting the medians to be calculated closely, the schedule called for a classification of wage-earners by their precise daily rates of pay. In tabulation, however, the employees have necessarily been grouped according to certain limits, and the median in each case accordingly appears not as a single rate but as a group, with upper and lower limits 5 cents apart. It follows that the median group itself covers a considerable number of employees and that the numbers above and below the median group are not, as a rule, exactly equal.

Tables 53 and 54 show, for the same wage-earners who are covered by Tables 51 and 52, the median groups of wages for different occupations, the percentage of the total number within each occupation who received wage rates falling within the median group, and the percentages of those above and of those below the median rates.

TABLE 53.—*Median rate of wages and percentage of classified wage-earners receiving above, below, and median rate—private stations: 1902.*

CLASS OF OCCUPATION.	Median rate (dollars).	PER CENT OF WAGE-EARNERS RECEIVING— Median rate.	Above median rate.	Below median rate.
All classes	2.00 to 2.04	18.9	36.9	44.2
Foremen	2.85 to 2.89	1.4	49.8	48.8
Inspectors	2.00 to 2.04	23.1	44.3	32.6
Engineers	2.00 to 2.04	15.0	41.6	43.4
Firemen	1.75 to 1.79	9.8	43.0	47.2
Dynamo and switchboard men	2.00 to 2.04	19.0	35.5	45.5
Linemen	2.00 to 2.04	17.4	42.3	40.3
Mechanics	2.00 to 2.04	25.6	44.9	29.5
Lamp trimmers	1.90 to 1.94	1.1	49.7	49.2

TABLE 54.—*Median rate of wages and percentage of classified wage-earners receiving above, below, and median rate—municipal stations: 1902.*

CLASS OF OCCUPATION.	Median rate (dollars).	PER CENT OF WAGE-EARNERS RECEIVING— Median rate.	Above median rate.	Below median rate.
All classes	1.75 to 1.79	4.6	47.2	48.2
Foremen	2.45 to 2.49	4.0	50.0	46.0
Inspectors	2.25 to 2.29	20.8	29.2	50.0
Engineers	1.95 to 1.99	3.2	47.5	49.3
Firemen	1.50 to 1.54	12.8	39.5	47.7
Dynamo and switchboard men	1.75 to 1.79	7.9	48.5	43.6
Linemen	1.75 to 1.79	6.5	43.7	49.8
Mechanics	2.25 to 2.29	17.4	37.0	45.6
Lamp trimmers	1.80 to 1.84	4.9	49.0	46.1

Table 53 shows that the median rate of wages in private stations was $2 to $2.04 for all classes and for inspectors, engineers, dynamo and switchboard men, linemen, and mechanics, 18.9 per cent of all wage-earners included in Table 51 receiving this rate. The median rate for foremen was $2.85 to $2.89; 1.4 per cent receiving this rate.

As shown in Table 54, 4.6 per cent of the wage-earners in municipal stations received the median rate for all classes, $1.75 to $1.79. The median rate for engineers was $1.95 to $1.99; 3.2 per cent received that rate and only 49.3 per cent received less. The median rate for firemen was only $1.50 to $1.54, and 47.7 per cent received a lower rate.

When it is considered that the vast majority of municipal stations are in very small communities, it is not surprising that the private stations situated in communities where the higher cost of living must necessarily govern conditions, should pay a larger proportion of the higher wages. There is no superficial reason why an artisan should work for a municipal station at a lower rate than he would for a private station, even if it be conceded that the employment of wage-earners in municipal stations might be governed by political considerations. This apparent difference might possibly disappear to some extent if the number of hours constituting the day's work were taken into consideration. It is a well-known fact that the eight hour day is a legal requirement for municipal work in some states, and would therefore apply in small as well as in large communities. Another fact that has bearing upon the conditions is that many of the municipal stations are operated chiefly or solely to supply a small number of lamps for street lighting during a restricted number of hours of darkness, and hence in such stations the nominal working day would involve fewer hours of occupation than it would in private stations or in other stations doing all kinds of electric work all day long; consequently the rate of pay would be lower in the municipal stations.

Daily wages and median rates, by states.—In Tables 95 and 96 the statistics of the wage-earners shown in Table 50 are presented, by states and territories, for private and municipal stations, respectively, the number of wage-earners being given for all occupations; and also for the more important occupations separately, according to daily wages within stated 25-cent limits; the 5-cent group, within which the median wage falls, is also given in each case.

The highest wages in private stations were paid in Montana, where the median for all classes of wage-earners was $3 to $3.04. Other states approaching this high average are found in the Western group. Important states that had a median of $2 to $2.04 were New York, New Jersey, Missouri, Minnesota, and Connecticut. In the Southern states the median rate was very low, it being $1.50 or less in a number of states. In Montana the median rate for engineers was $4 to $4.04. In no other state was this high rate approached, but in a number of important states daily wages of from $2 to $2.50 were paid.

For municipal stations few states reported a median rate of more than $2.04 for all classes of wage-earners. In fact none of the larger states except California, Illinois, and Massachusetts did so.

The other data in these tables do not call for comment, but will be of interest to the student of sociology.

CHAPTER V.

PHYSICAL EQUIPMENT.

General divisions.—The physical equipment of central stations by means of which service is rendered to the community embraces three important subdivisions.

The first of these comprises the power and generating station equipment, with which is included that of substations. The second includes all items relating to the line construction, extending from the power stations and substations in the shape of mains, feeders, and subsidiary circuits to the street circuits or to the premises of consumers. With this should, in all propriety, be grouped apparatus such as transformers, which are very often placed on the line itself, although they are frequently to be found on consumers' premises. The third group of physical equipment includes the meters, the arc and incandescent lamps, the stationary motors, and some other apparatus, although it is often difficult to distinguish the apparatus belonging to the stations from that belonging to the consumer.

In preceding tables gross figures have been presented for some of the items of the physical equipment. Tables 73 to 76 and 83 to 86 give for private and municipal stations, respectively, detailed statistics, by states, concerning the electric line construction, the power and generating apparatus within the station, the transmitting equipment in the substations, the transformers, the meters, the output of current, the number and varieties of arc and incandescent lamps, and the number of stationary and railway car motors.

Ownership of equipment.—It is to a large extent the present practice for the customers employing motors driven by electric current from central stations to own the motors outright. In a great many instances the incandescent lamps connected to the central station circuits are installed on circuits within buildings, in such a manner that neither circuits nor sockets constitute part of the physical equipment of the company supplying the current to the building, although some companies make a free service of renewal lamps to them. Arc lamps, where used for street lighting, have remained, with few exceptions, wholly the property of the stations operating them under contract with the city or the municipality itself; and this is equally true of all arc lamps supplied to the commercial customers, whether by private stations or by municipal plants. It is an unusual thing for the proprietor of a store or building to own the arc lamps operated on his premises if such lamps happen to be energized with central station current, although where the plants are of the description known as "isolated," such lamps, as well as all other apparatus, are owned by the owner of the building or by the tenant. Transformers have likewise remained, as a general thing, the property of the stations operating them, being, in fact, moved from place to place according to the local requirements of the system. Meters on central station circuits are, it is safe to say, invariably the property of the stations, and are taken out in case the service is discontinued. The apparatus under consideration is, therefore, that which is the property of the central station strictly, subject to the limitations that have been pointed out with regard to one or two classes of consumption appliances.

I.

EQUIPMENT OF POWER AND GENERATING PLANTS.

General statistics of power plants.—As already shown in Table 1 the total horsepower capacity of steam engines and water wheels of central electric stations was 1,818,413 horsepower. Of this amount 1,379,941 horsepower, or 75.9 per cent, was the indicated capacity of the steam engines, and 438,472 horsepower, or 24.1 per cent, the stated capacity of the water wheels. The indicated capacity of steam engines and water wheels in the stations operated under private ownership was 1,660,177 horsepower, or 91.3 per cent of the total, while the capacity of those in stations operated under municipal control was 158,236 horsepower, or 8.7 per cent.

In addition to the power shown in Table 1 there were reported 165 gas engines, having a capacity of 12,181 horsepower, and 365 auxiliary steam engines, having a capacity of 14,454 horsepower. As a matter of fact, the gas engines should be regarded as part of the prime moving power plant, it being probable that practically all such engines reported were attached to dynamos. It is also probable that some of the auxiliary steam engines were in the nature of a reserve as well as for use in operating subsidiary apparatus in connection with the plant. Tables 74 and 84 present, for the United States and for each of the states and territories, detailed statistics of these engines and water wheels, classified according to size, as well as details concerning the dynamos and other apparatus in the private and municipal stations, respectively.

General statistics of steam engines.—Table 55 shows the number and horsepower of the steam engines in both private and municipal stations, also the proportion that the equipment of each class of stations is of the total.

TABLE 55.—*Steam engines—private and municipal stations, and percentage each class is of total: 1902.*

CLASS OF ENGINE.	Total.	Private stations.	Municipal stations.	PER CENT— In private stations.	PER CENT— In municipal stations.
Total:					
Number	5,930	4,870	1,060	82.1	17.9
Horsepower	1,379,941	1,232,923	147,018	89.3	10.7
500 horsepower and under—					
Number	5,451	4,407	1,044	80.8	19.2
Horsepower	849,336	715,418	133,918	84.2	15.8
Over 500 and under 1,000 horsepower—					
Number	278	266	12	95.7	4.3
Horsepower	193,570	184,670	8,900	95.4	4.6
1,000 horsepower and over—					
Number	201	197	4	98.0	2.0
Horsepower	337,035	332,835	4,200	98.8	1.2

Of the total horsepower of the steam engines in use in central electric stations 89.3 per cent represents engines in private stations and 10.7 per cent those in the municipal stations. Not only does the horsepower of the engines in the municipal stations form a small proportion of the total, but the engines are, as a rule, smaller than the engines in stations operated under private ownership. This is shown in the arrangement of the engines into three groups according to their horsepower. The vast majority of the engines in the municipal plants are in the group of the smallest capacity, while those of a larger capacity are almost all in private stations. The greatest disparity between the two groups of stations is in the group having engines with a capacity of 1,000 horsepower and over. This included 201 engines with a total capacity of 337,035 horsepower. Of these only 4, with a capacity of 4,200 horsepower, were reported by municipal stations. It will be noted that even these 4 came barely within the classification, while the 197 in the private stations rose to an average of very nearly 1,700 horsepower each. These facts should not be overlooked in a consideration of the various costs and economies affecting the production and sale of current, or the rates at which service can be supplied, it being a truism that power production on a large scale is cheaper than power production on a small scale. Table 56 brings out these facts more clearly by showing the percentages that the number and horsepower of engines in the different groups were of the total number and horsepower of the engines in all stations, and in private and municipal stations, respectively.

TABLE 56.—*Percentages that the number and horsepower of the different classes of steam engines are of total—private and municipal stations: 1902.*

CLASS OF ENGINE.	Total.	Private stations.	Municipal stations.
Total:			
Number	100.0	100.0	100.0
Horsepower	100.0	100.0	100.0
500 horsepower and under—			
Number	91.9	90.5	98.5
Horsepower	61.6	58.0	91.1
Over 500 and under 1,000 horsepower—			
Number	4.7	5.5	1.1
Horsepower	14.0	15.0	6.0
1,000 horsepower and over—			
Number	3.4	4.0	0.4
Horsepower	24.4	27.0	2.9

The engines having 500 horsepower and under formed 91.9 per cent of all engines, their capacity being 61.6 per cent of the total capacity. The smaller engines and their total horsepower form a considerably larger proportion of the total for the municipal stations than they do of the total for the private stations, while the larger engines, those having over 500 horsepower, form a larger proportion of the total in the private than in the municipal stations. In private stations the engines of 1,000 horsepower and upward were 3.4 per cent of the number and 24.4 per cent of the horsepower, but in the municipal stations they were only four-tenths of 1 per cent of the number and 2.9 per cent of the horsepower. While it is evident that the smaller type of engines largely predominates in all the stations taken collectively, the proportion of them in the municipal stations is overwhelming. Such figures are a strong indication of the facts already emphasized in other ways, that, taking the country as a whole, outside of the large cities the electric light and power industry is still based on what has to be considered as a quite small and relatively expensive unit of motive power.

The number of engines per municipal station is not much above one and even in the private stations the average does not rise to two, this fact showing how very general the dependence is upon one engine, even a reserve for accidents and emergencies being lacking. The average capacity per plant for the municipal stations was about 180 horsepower and in the private stations almost 440 horsepower. It will be remembered, however, that if the stations using waterpower exclusively be deducted from the totals these averages will be raised somewhat.

Auxiliary steam engines.—It is possible that in some of the stations the auxiliary steam engines would come to the relief of the main plants in moments of distress. In private stations there were 329 such engines, with 13,619 horsepower capacity. In the municipal stations there were few auxiliary engines, the number being but 36, with 835 horsepower; evidently they were in reality merely auxiliaries in most cases, for although one is reported of 200 horsepower and one of 100 horsepower,

the average capacity for the remainder was not quite 16 horsepower. In the private stations the auxiliary steam engines had an average capacity of 41 horsepower, and while many of the smaller ones were used for pumping, a number were of sufficient size to take care of a good sized arc lighting machine, to carry a moderate day load, or to charge storage batteries.

Steam engines in stations, classified according to population of places in which located and dynamo capacity.—Tables 87 to 90 show the equipment of central electric stations, classified according to the population of the places in which they were located. These tables show very strikingly the use of the larger steam engines in the larger cities, the number of large engines rising rapidly as the population increases. Thus, as shown in Table 87, for the purely electric private stations, of the steam engines of 500 horsepower and under, 1,593 were in places with less than 5,000 inhabitants and only 119 in places of a population of more than 500,000, while of the engines of 500 horsepower and over there were only 2 in places with less than 5,000 inhabitants, 9 in places with from 5,000 to 25,000, 67 in places with from 25,000 to 100,000, 104 in places with from 100,000 to 500,000, and 120 in places with more than 500,000.

In Table 88, for private stations operated in connection with other business, the results are similar to those shown in the preceding table, although the variations are less marked, which is but natural since many of these stations are operated merely as accessories to some other business.

Municipal stations, for which the statistics are shown in Tables 89 and 90, have, as a rule, very small plants, and consequently nearly all of their steam engines are of the smaller sizes. The few engines of the larger sizes are found only in the large cities.

Tables 91 to 94 show statistics of stations, classified according to the horsepower capacity of dynamos. There are very few stations having a large dynamo capacity that do not have some of the smaller sized engines in connection with their larger ones. Thus, in the purely electric private stations having a dynamo capacity of 5,000 horsepower and over, there were 162 steam engines of 500 horsepower and under, 82 of over 500 but under 1,000 horsepower, and 121 of 1,000 horsepower and over. These figures appear to indicate that the smaller engines are used during certain parts of the day when there is comparatively little call for current, and as a reserve in case of accident to the larger engines.

Table 92 follows the same general line as Table 91. Tables 93 and 94, for municipal stations, have so few steam engines of the larger sizes that they do not call for comment.

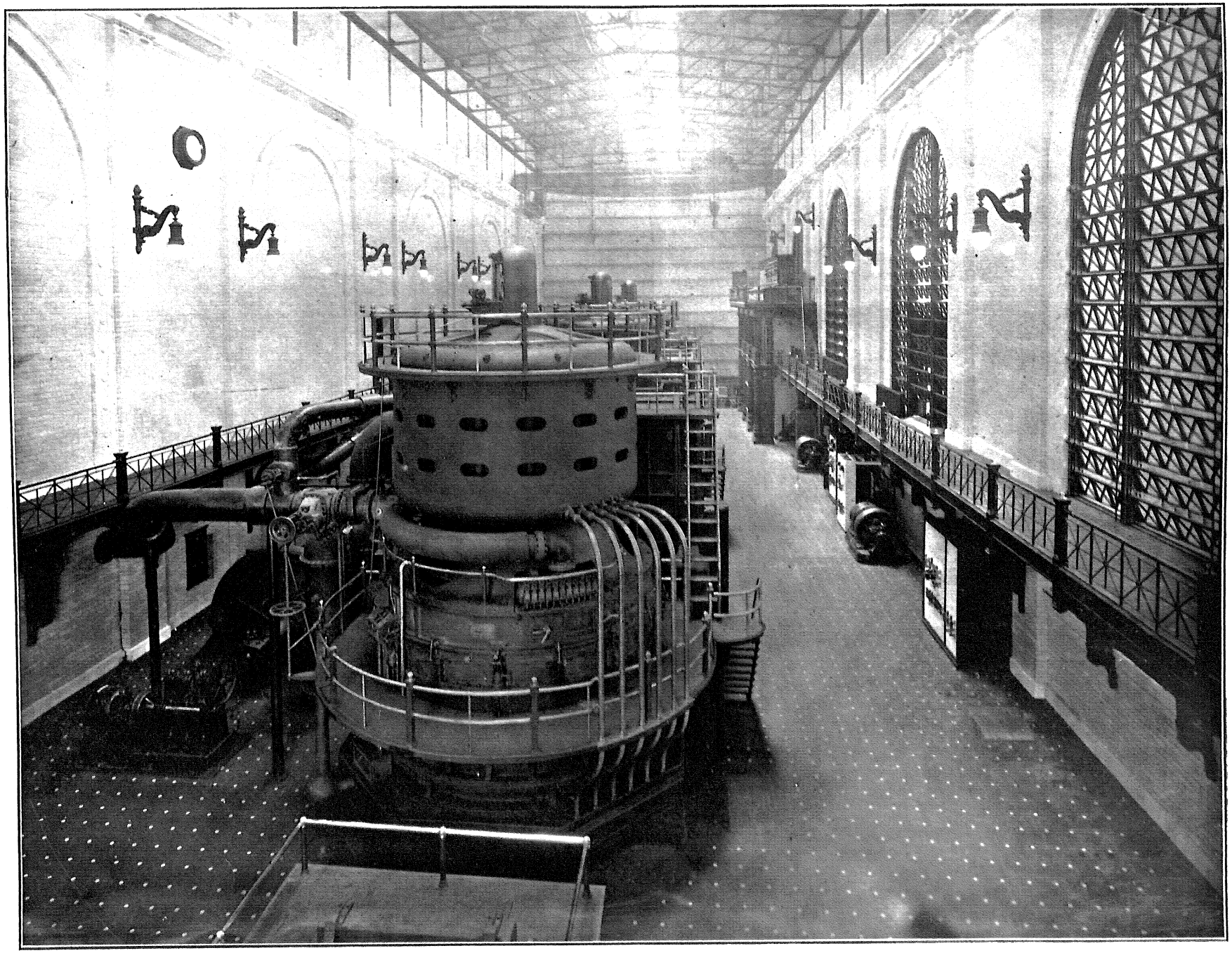
General statistics of water wheels.—Of the primary motive power plants in use in central stations the considerable proportion represented by hydraulic development is enumerated and broadly analyzed in Table 57. This table shows the number and horsepower capacity of water wheels divided into three groups as to size, in all, in the private, and in the municipal stations, respectively, and the proportion which those in each class of stations are of the total.

TABLE 57.—*Water wheels—private and municipal stations, and percentage each class is of total: 1902.*

CLASS OF WATER WHEEL.	Total.	Private stations.	Municipal stations.	PER CENT— In private stations.	PER CENT— In municipal stations.
Total:					
Number	1,390	1,308	82	94.1	5.9
Horsepower	438,472	427,254	11,218	97.4	2.6
500 horsepower and under—					
Number	1,192	1,112	80	93.3	6.7
Horsepower	174,559	164,981	9,578	94.5	5.5
Over 500 and under 1,000 horsepower—					
Number	85	84	1	98.8	1.2
Horsepower	57,160	56,520	640	98.9	1.1
1,000 horsepower and over—					
Number	113	112	1	99.1	0.9
Horsepower	206,753	205,753	1,000	99.5	0.5

For all stations, 1,390 water wheels were reported, and they had a stated capacity of 438,472 horsepower. Of these 1,308, with a capacity of 427,254 horsepower, were in private stations and 82, with a capacity of 11,218 horsepower, in municipal stations, this latter class of stations having 5.9 per cent of the number and 2.6 per cent of the horsepower. As with the steam engines so with the water wheels; by far the largest number were in the group of 500 horsepower and under, the municipal stations having only 2 of a greater capacity. No fewer than 1,192 wheels, with a total of 174,559 horsepower, were in this group; of these all but 80, with 9,578 horsepower, were in private stations. There were 85 wheels, with a total of 57,160 horsepower, in the group with a capacity of between 500 and 1,000 horsepower, and 113, with a total of 206,753 horsepower, in the group with a capacity of 1,000 horsepower and over. In the private stations the average for all the wheels in the second group was slightly over 672 horsepower, and for those in the largest group the average was 1,837 horsepower. It will be interesting to note that the group of the small water wheels comprised 39.8 per cent of the total horsepower, while the horsepower of the wheels in the group of 1,000 horsepower and over was 47.2 per cent.

Water wheels in private stations.—According to Table 74 the water wheel power plant equipment of private stations showed a remarkably wide distribution throughout the country, waterpower being used in all but a few of the smaller and less important states and territories. But while the smaller steam engines represented more than half of the total capacity of steam engines, the opposite is true as regards water wheels. The 196 water wheels of over 500 horsepower aggregated 262,273 horsepower, or nearly two-thirds of the total, while the



INTERIOR OF GENERATING PLANT OF CHICAGO EDISON AND COMMONWEALTH COMPANIES, CHICAGO.

This plant is a striking exemplification of the latest modern practice in employing dynamos driven by steam turbines. The dynamo and turbine together constitute a complete turbo-generator unit.

112 wheels of 1,000 horsepower and over, included in the 196 wheels, were of 205,753 horsepower, or very nearly one-half of the total. The average size of all the wheels was 326 horsepower, while the 1,112 constituting the most numerous group averaged only 148 horsepower each.

New York occupies a conspicuous place at the head of the list, with 236 wheels and a total of 128,271 horsepower. Although the development of Niagara Falls power figures very materially in the high standing of New York for hydraulic development, the distribution of waterpower throughout the state is very general. Only 47 of the wheels were over 500 horsepower, while the average of wheels having less than 500 horsepower was only 157 horsepower each. The influence of the Niagara Falls development is most clearly shown in the group of large wheels, there being in this group 35 wheels of a total of 91,600 horsepower, an average of 2,617 horsepower per wheel. California, with a total of 130 wheels and 78,483 horsepower, was the second state in the use of waterpower for the generation of electric current. Here again the distribution was general, the wheels varying greatly in size, there being by groups 79 with 12,771 horsepower, 23 with 15,574 horsepower, and 28 with 50,138 horsepower. This last group comprised almost two-thirds of the total stated capacity. The average capacity of wheels in the first group was 161 horsepower, while the average of those in the last group was 1,790 horsepower. Considerable utilization of waterpower is shown in the New England states, Vermont leading with 64 water wheels of 13,075 horsepower. The hydraulic utilization was also noteworthy in several of the Central and Western states, namely, California with 130 wheels and 78,483 horsepower, Colorado with 42 wheels and 12,750 horsepower, Illinois with 52 wheels and 9,505 horsepower, Michigan with 95 wheels and 12,915 horsepower, Montana with 44 wheels and 24,000 horsepower, Oregon with 44 wheels and 11,118 horsepower, Utah with 25 wheels and 18,285 horsepower, Washington with 41 wheels and 17,238 horsepower, and Wisconsin with 74 wheels and 7,423 horsepower. The states in the Far West were more conspicuous than those of New England or the Middle West in the employment of large wheels. For example, 11 of the 25 wheels in Utah were of over 1,000 horsepower each, while of the 42 in Colorado 2 were of over 1,000 horsepower and 6 were of between 500 and 1,000 horsepower and averaged more than 700 horsepower each. Georgia, with 10 wheels of 5,989 horsepower, of which 4 were of 5,150 horsepower, is one of the Southern states giving attention to waterpower or its better availability. South Carolina was also notable for its utilization of waterpower. It had 9 wheels of 10,415 horsepower, 8 of which were of 10,165 horsepower or an average of 1,270 horsepower each. In Pennsylvania, in spite of the nearness of the central stations to the coal measures, waterpower was utilized quite freely although in small units, there being 48 wheels with a total of 6,703 horsepower; 46 of these were of less than 500 horsepower each and in fact did not average much over 100 horsepower each.

Water wheels in municipal stations.—The use of waterpower by the municipal stations was, as already noted, not very extensive, there being only 82 wheels with a total of 11,218 horsepower, an average of 136 horsepower per wheel. There were only 2 wheels of the larger sizes—one of 640 horsepower at Lyndonville, Vt., and one of 1,000 horsepower at Marquette, Mich. Only 18 of the states and territories reported the use of hydraulic power for municipal station purposes. The state with the largest resources of this kind was Michigan, with 19 wheels of 3,170 horsepower capacity. Next came Vermont, with 16 wheels of 3,221 horsepower. The figures for the other states do not call for comment.

Water wheels in stations, classified according to population of places in which located and dynamo capacity.—Tables 87 to 90 show the water wheels of stations, classified according to the population of the places in which located, while Tables 91 to 94 show the water wheels of stations, classified according to horsepower capacity of dynamos.

From Table 87 it will be seen that 499, or more than half of the water wheels in purely electric private stations, were found in places with a population of less than 5,000; 220, in places of 5,000 to 25,000; 126, in places of 25,000 to 100,000; and 51, in places of 100,000 to 500,000. It will be noticed that the capacity of the wheels in places of 5,000 to 25,000 was 139,025 horsepower, much more than in any other group. This is accounted for by the fact that a number of large waterpower plants are located in these small places, even though part of the current generated there is transmitted to the larger cities. Comparatively few of the larger cities employed waterpower for generating current, the 51 wheels reported in places of 100,000 to 500,000 inhabitants being limited to a very few cities.

In the private stations operated in connection with other business, the same general proportions and conditions are found, while in the municipal stations the number of the larger wheels is so few as not to call for comment.

Equipment of stations, classified according to the kind of power used.—Tables 40 and 41 show the statistics of equipment and output of current for stations classified according to the kind of power used. The figures for the last class shown in the tables are greatly influenced by the large plants at Niagara, and were it not for these plants the averages would be quite small.

As shown by Table 42, in the plants operated exclusively by waterpower there were 612 water wheels with a capacity of 217,261 horsepower and 750 dynamos with a capacity of 171,988 horsepower. According

to Table 1, the total number of water wheels in private and municipal stations was 1,390 and their capacity was 438,472 horsepower. The two tables indicate, therefore, that 44 per cent of the wheels and 49.5 per cent of their capacity were in stations operated exclusively by waterpower. The output of these 312 plants was 258,698,131 kilowatt hours for the year, this current being consumed in part by 9,060 arc lamps and 599,938 incandescent lamps.

Generating equipment.—Equal in importance with the power plant equipment in central stations, and necessarily so closely associated with it that the two form one element for consideration, is the generating plant equipment; that is, the dynamos which furnish current to the consumption circuits. The boilers, engines, and water wheels employed for prime motive power in this work are of well-nigh every variety, while the dynamos themselves comprise a bewildering assortment of shapes and sizes and are based upon varying theories of construction and design. The whole object, however, of the power and generating plant equipment is to secure the revolution of electro-magnets or coils of wire in the close vicinity to and in the "field of force" of other electro-magnetic coils of wire, such magnets and coils constituting in their relationships a dynamo electric machine. It is a matter of indifference whether the "armature" or the "field" magnet revolves; the engine or the water wheel effects its purpose so long as it causes the coils of wire to which its shaft is attached to change their positions frequently in the unseen "field of force," thus generating current. The engines may be single or compound, horizontal or vertical, condensing or noncondensing; the water wheels may be undershot or overshot, impulse or otherwise, so long as they serve the purpose of imparting rotary motion to the dynamo or generator, which may be, as it almost invariably is in later types, directly connected to the shaft of the prime mover, or, as it was in most of the early types, intermediately connected by means of belts and countershafting. The statistics relative to the power plant equipment show the figures of engines and water wheels, without regard to the distinctions of principle in their construction. In like manner the generating plant equipment might be discussed in far greater detail were this report strictly a technical treatment of the subject, but since it deals with commercial and industrial conditions, it was deemed sufficient by the Bureau of the Census to group the dynamos into three large main classes which answer sufficiently the purpose and scope of the investigation.

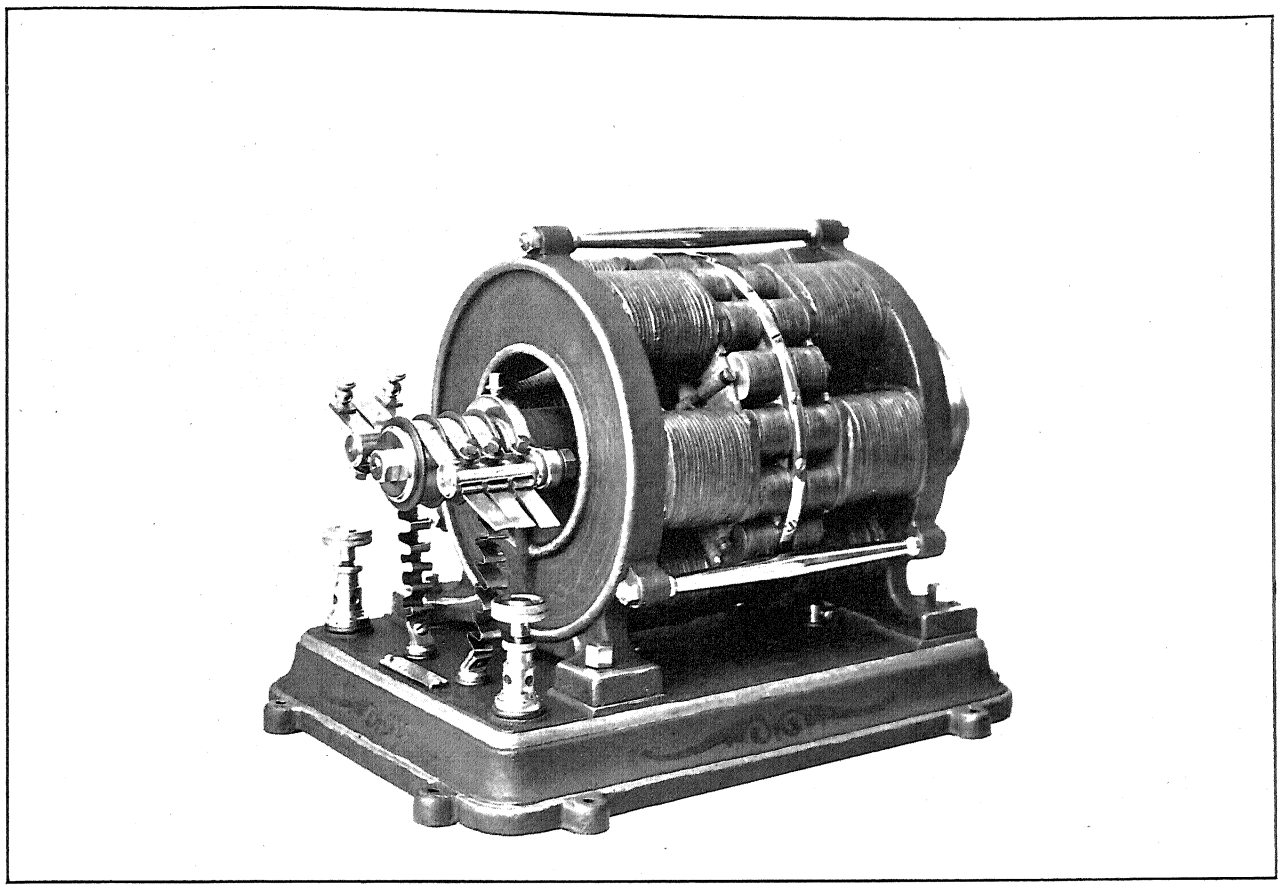
Classification of dynamos.—The generating plant equipment is divided into three groups, namely, direct current constant voltage dynamos, direct current constant amperage dynamos, and alternating and polyphase current dynamos. These three classes answer in their general range to the specific lines of work that have been developed by American central stations. The first class of direct current constant voltage machines deals with and includes essentially all those intended for supplying current to incandescent lighting and stationary motor circuits. At the outset of the industry such machines were almost without exception limited purely to incandescent lighting; but to-day, as a result of the evolution of the industry, a great many of them are furnishing current to motors and are also carrying on their circuits arc lamps, for which originally the machines in the second category, namely, those of the direct current constant amperage type, were built exclusively. A great many such constant amperage machines are still in use and are likely to be devoted solely to arc lighting in the smaller stations of the country, as will appear later from the analysis.

The third group of apparatus, alternating current dynamos, is a large and rapidly growing class which embraces in its capabilities the power of easily and readily furnishing current for all classes of lamps and for stationary motors, although between the points of generation and consumption manipulation and transformation of current may be necessary. While electric light and power in American isolated plants have been and seem likely to continue to be governed by the conditions of direct current dynamos, the central station industry is shifting rapidly to the fundamental basis of alternating current generation by means of single phase or polyphase dynamos. This broad statement is subject to qualifications which would not, however, lessen the value of the assertion.

General statistics of generating plants.—The gross figures for the three classes of dynamos give a total of 12,484 machines, with a stated capacity of 1,624,980 horsepower. Table 58 shows the distribution of these dynamos according to the character of the current and according to location in private or municipal stations, also the proportion of each variety of machines in each class of stations.

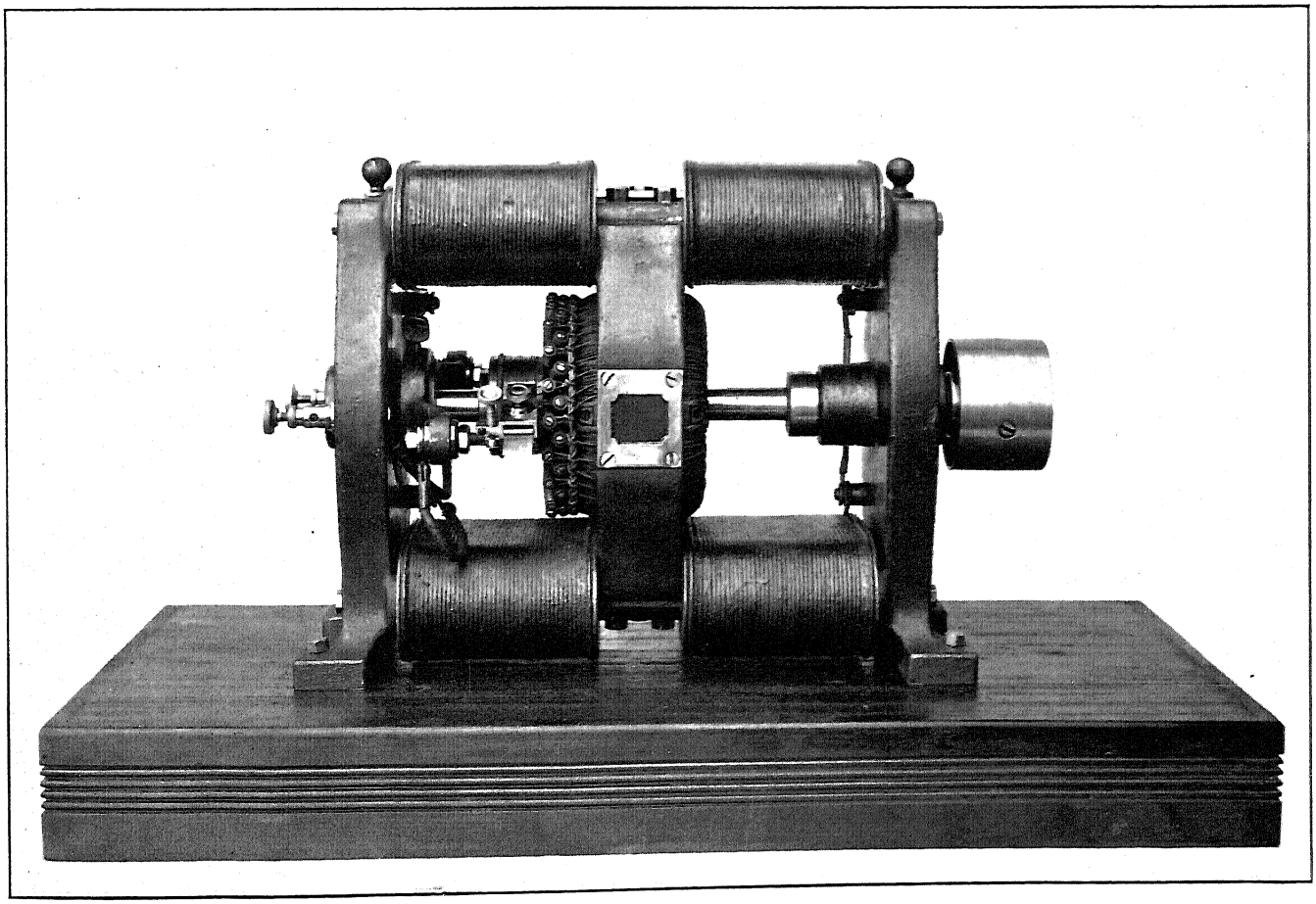
TABLE 58.—*Dynamos—private and municipal stations, and percentage each class is of total: 1902.*

VARIETY OF DYNAMO.	Total.	Private stations.	Municipal stations.	PER CENT— In private stations.	PER CENT— In municipal stations.
Total:					
Number	12,484	10,662	1,822	85.4	14.6
Horsepower	1,624,980	1,472,996	151,984	90.6	9.4
Direct current, constant voltage—					
Number	3,823	3,405	418	89.1	10.9
Horsepower	442,446	418,913	23,533	94.7	5.3
Direct current, constant amperage—					
Number	3,539	2,957	582	83.6	16.4
Horsepower	195,531	157,768	37,763	80.7	19.3
Alternating and polyphase current—					
Number	5,122	4,300	822	84.0	16.0
Horsepower	987,003	896,315	90,688	90.8	9.2



"WOOD" DYNAMO BUILT IN 1879.

This machine includes many of the features of the modern dynamo, and is the multipolar type.



"WOOD" SERIES ARC DYNAMOS BUILT IN 1880.

This series arc dynamo was the forerunner of a well-known type that has survived for twenty-five years; designed for 9.6 amperes and 50 volts, at 2,200 revolutions of the armature per minute.

In view of the fact that municipal stations are so largely devoted to street lighting, it is natural that for them the class of direct current constant amperage arc machines should be the largest. The relatively small amount of incandescent lighting done in municipal stations is also brought out by the fact that in such stations direct current constant voltage dynamos formed only 10.9 per cent of the total number and had only 5.3 per cent of the total horsepower. The machines in most general use in both classes of stations were those generating alternating current, single or polyphase. Of the total number of these machines reported, 16 per cent with 9.2 per cent of the horsepower were operated in municipal stations.

Table 59 shows the percentages that the number and horsepower of the different varieties of dynamos are of the total number and total horsepower of all dynamos in all stations and in both private and municipal stations.

TABLE 59.—*Percentages that the number and horsepower of the different varieties of dynamos are of total—private and municipal stations: 1902.*

VARIETY OF DYNAMO.	Total.	Private stations.	Municipal stations.
Total:			
Number	100.0	100.0	100.0
Horsepower	100.0	100.0	100.0
Direct current, constant voltage—			
Number	30.6	32.0	22.9
Horsepower	27.2	28.4	15.5
Direct current, constant amperage—			
Number	28.4	27.7	32.0
Horsepower	12.0	10.7	24.8
Alternating and poly phase current—			
Number	41.0	40.3	45.1
Horsepower	60.8	60.9	59.7

Alternating current apparatus, in spite of the lateness of its introduction, had at the time of the collection of these statistics become the largest class of apparatus employed in central station work, as shown by the gross figures. Not only did such machines constitute the largest proportion as to number, but their proportion of the total horsepower was also considerably in excess, indicating, as might be expected from the later developments in the industry, the employment of a much larger type of machine of this variety than is now to be found in service either for direct incandescent lighting or for direct current arc lighting.

According to Table 59, direct current constant voltage machines were 30.6 per cent of the number and had 27.2 per cent of the horsepower. Direct current constant amperage or arc machines were slightly inferior as to number, the rate being 28.4 per cent, and very much less as to horsepower, for which the rate was 12 per cent. On the other hand, the alternating class embraced 41 per cent of the number and 60.8 per cent of the horsepower. It may here be pointed out that the use of alternating and polyphase machines in municipal stations has kept pace with their use in private stations, the rates being 60.9 per cent for private stations and 59.7 per cent for municipal stations.

Dynamos in private stations.—Table 74 shows the division of dynamos, by states and territories, in private stations and includes also in the classification of dynamos apparatus 184 boosters of 17,735 horsepower, and 131 rotaries of 63,683 horsepower. Two states were very largely in the lead as to number and capacity of dynamos, namely, New York with 1,408, with a total of 245,823 horsepower, and Pennsylvania with 1,215, with a total of 155,377 horsepower.

The large states had a considerable proportion of alternating current apparatus. Of the dynamos in New York 690, with 166,427 horsepower, were of this class. In Pennsylvania there were 405, with 83,793 horsepower; in Illinois 336, with 58,099 horsepower; and in Massachusetts 233, with 59,143 horsepower. These alternating machines were frequently of considerable size, those in New York, for instance, averaging over 241 horsepower. The fact that in this state there were only 33 dynamos of 1,000 horsepower and over, the total capacity being 79,520 horsepower, would imply the presence of a large number of the smaller and older single phase alternating machines, as distinguished from the polyphase machines, now built only in the very large sizes. In fact the central station industry, as a whole, still employed a large number of these smaller dynamos which marked the introduction of that kind of current some years ago, such machines being not much if any larger than the average of 193 horsepower each. In the other states the relative size of the direct and alternating current apparatus, exclusive of that for arc lighting, followed closely the same relative magnitudes.

The arc lighting machines reported had an average capacity of a little over 53 horsepower. In New York the average was less than 50 horsepower, the probability being that in that state the industry had already reached the stage where a great many of the arc lamps were carried on the incandescent lighting circuits, instead of on circuits and machines of the earlier series arc type, such as would still prevail in smaller communities. It will be noted that in several of the states for which the reports showed a small number of arc lighting machines, the average was considerably above the average for the country as a whole. Thus in Indian Territory the single machine reported was of 60 horsepower. In New Mexico the 3 with 183 horsepower, averaged 61 horsepower. In Utah the 10 with 800 horsepower, averaged 80 horsepower. Toward the close of what was a definite period of series arc lighting with machines of this type, the tendency was to increase the capacity of dynamos very materially, so that a single machine would energize a circuit with as many as 150 series arc lamps, and thus enable the business to be done more economically and at the same time over a larger area. Moreover, in order to drive the current through this long circuit of wire and lamps, the pressure or voltage had to be increased pro-

portionately, and while better precautions were taken as to insulation, it was universally felt that such circuits were far too dangerous to life and property to be permitted a very general adoption, even if the wires reached the poles by underground conduits. These statistics as to arc lighting dynamos give a very fair indication of the continued existence and use of many of the larger arc machines, although they were built and installed prior to the time when the alternating current made its appearance and by its different method of current distribution obviated the necessity of their employment.

Dynamos in municipal stations.—Table 84 presents the statistics, by states and territories, for dynamos in the municipal stations of the country, there being, as already noted, 1,822 dynamos with a total of 151,984 horsepower, of which exactly 1,000 with 61,296 horsepower were of the direct current type, leaving for the class of alternating and polyphase current 822 with 90,688 horsepower.

An inspection of the table shows that a great many of the machines were very small. The direct current machines considered as one group averaged 61 horsepower and the alternating current machines averaged 110 horsepower. In Colorado the 1 direct current incandescent lighting machine was of only 30 horsepower; in Connecticut the 4 incandescent lighting machines had a total capacity of only 80 horsepower and the 2 arc machines had a total of only 40 horsepower, the average for both kinds of machines being but 20 horsepower. The single direct current incandescent lighting machine in Massachusetts was of 80 horsepower, while in Oregon the 3 of the same type had a total of only 39 horsepower, and in South Carolina there were 2 with a total of only 35 horsepower. In Vermont there were 3 with a reported total of 8 horsepower. It is difficult to conceive what useful or economical part machinery of such trivial capacity could play in any enterprise, whether private or municipal. For Vermont the reports showed also 3 direct current arc machines with a total of 70 horsepower, while 4 of the arc machines in Virginia had a total of but 75 horsepower. In West Virginia, however, the arc machines ran to the other extreme, 9 being reported with a total of 700 horsepower.

All the small machines, including the group of alternating current apparatus, were without question of the early single phase type. This dynamo electric apparatus for generating purposes was supplemented by a very small number of boosters and rotaries, there being 9 boosters with 176 horsepower and 1 rotary with 134 horsepower.

Dynamos in stations, classified according to population of places in which located and dynamo capacity.—Tables 87 to 90 show the statistics of dynamos for stations, classified according to the population of the places in which located, and Tables 91 to 94 show similar statistics for the stations classified according to horsepower capacity of generating equipment.

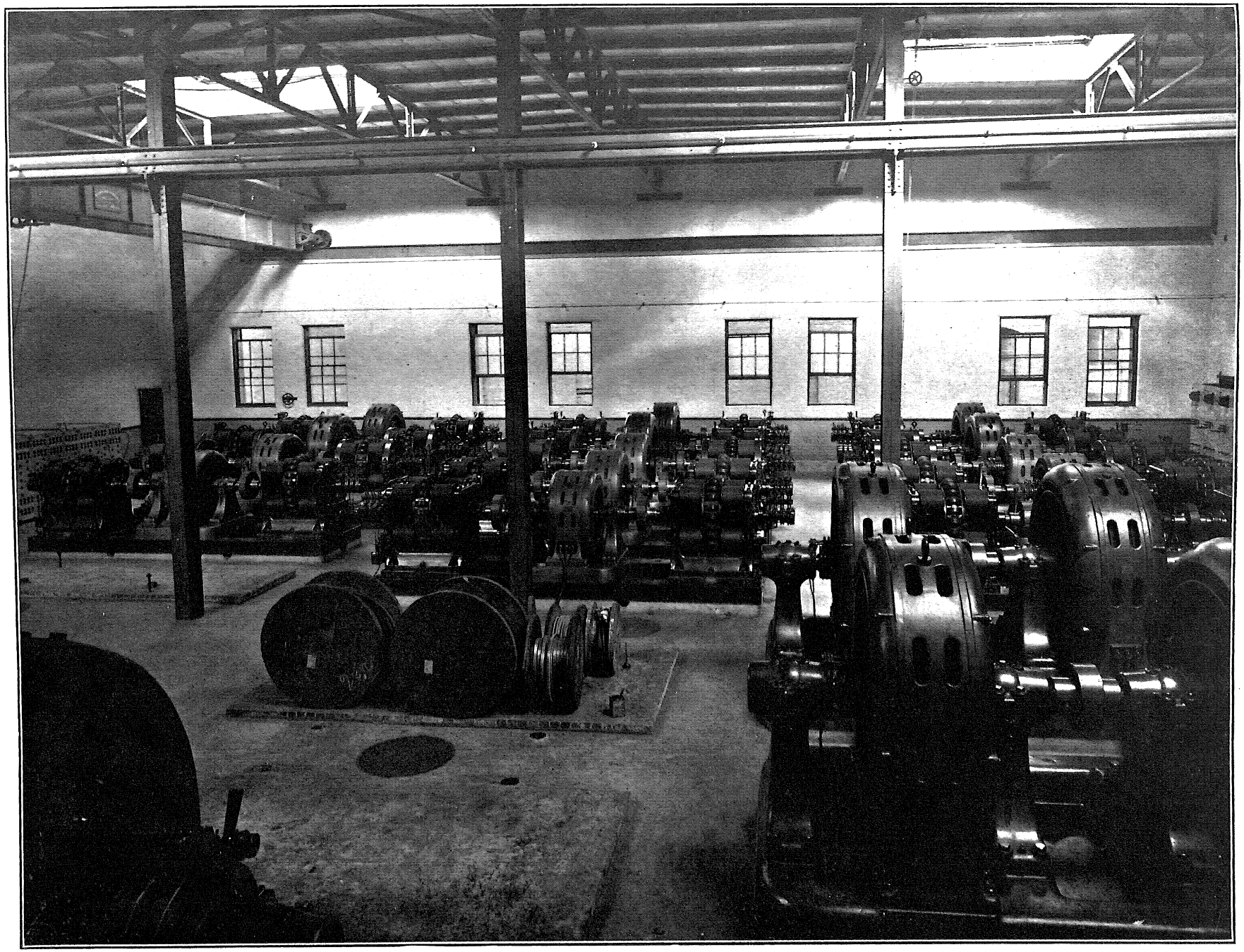
According to Table 87, in purely electric private stations, the places with a population of less than 5,000 had the largest number of dynamos, as well as the largest horsepower capacity. In a general way the number lessened as the population groups increased in size. Of the direct current, constant voltage dynamos, the larger cities reported the largest dynamo capacity. The dynamo capacity of the direct current constant amperage machines was almost uniform throughout all the population groups, while for the alternating and polyphase current machines the smaller places again had the highest horsepower capacity. There is no doubt that the stations located in the smaller places have a large amount of reserve machinery for use in case of accident, while in the larger cities the plants are larger and consequently do not require so large a numerical proportion of reserve machinery.

In Tables 89 and 90 are shown the effect of public arc lighting in the comparatively large number of direct current constant amperage machines in both the purely electric municipal stations and those operated in connection with other business, the totals for this class of dynamo being considerable.

Table 91 shows the dynamos in purely electric private stations, classified according to horsepower capacity of generating equipment. The very large proportion of dynamos found in the larger plants shows to what extent the current was being generated by a comparatively small number of stations. The 89 purely electric private stations with dynamo capacity of 2,000 or more horsepower reported a total of 590,229 horsepower, or more than half of the total for all the stations of this class. This condition is particularly striking in the alternating and polyphase dynamos, the capacity of these dynamos being 368,066 horsepower out of a total of 638,683 horsepower.

In the private stations operated in connection with other business a large proportion of the horsepower capacity is also found in the larger stations.

Substation equipment.—The early days of the electric lighting industry, like those of electric railways, knew nothing whatever of substations, and, indeed, had little or no necessity for that which has now become an important and vital adjunct for the distribution of current on the large scale required by modern operation. The original incandescent lighting system was of the direct current type, and was limited to a very restricted area, while the arc lighting circuit, also direct current, extended farther afield, although it did not embrace any larger area in its network of wires, but simply carried one single wire along a given thoroughfare and so continued, usually on some other street or streets, back to the generating plant. These conditions prevailed for several years, until the advent of alternating current on a practicable basis; although prior to that time attempts



BRUSH ARC LIGHTING GENERATORS, BUFFALO.

These arc lighting machines are driven in pairs by alternating current motors with current from Niagara Falls.

were made to increase the area covered from one station, chiefly by means of raising the voltage or pressure of the current at the central station. Even when the alternating current was introduced and the methods of its distribution were worked out, the substation did not immediately make its appearance, although rudimentary attempts in that direction were to be noted in the occasional grouping together of several transformers in what were known as "banks." These transformers receive the high voltage current and lower it in pressure for safer use on the consumption circuits, although they do not otherwise change the alternating character of the current.

While the single phase alternating current was shown to be available for incandescent lighting, and in some degree for arc lighting, it was, however, strictly limited to these two uses, not being available for stationary motors in general, for electric railway work, nor for storage batteries. Out of the necessities of electric traction, with its direct current motors, many of them operating several miles distant from the plant, arose the necessity for larger quantities of current deliverable at a high sustained voltage at remote points. Since it was inconvenient and expensive to have a number of scattered power plants for an electric railway system, the substation was evolved, the work done in alternating current power transmission assisting in the solution of the problem. These conditions will be dealt with in more detail historically in another chapter.

The substation, whether for electric lighting or for electric railway work, consists essentially of receiving or step-down transformers, to which the alternating polyphase current is brought by the distributing circuits at high voltage after being generated at the main power plant, which may be scores of miles away, but which in the average city system is usually from 5 to 15 miles distant. The step-down transformer lowering the voltage of the current delivers it to the rotary converter, a composite piece of dynamo electric apparatus, which, receiving it at one side or one end as alternating current, delivers it at the other end of the machine as direct current, either directly to the consumption circuits or to storage batteries. The current is stored wholly or in part. In a few instances in this country, and very generally in Europe, the substation apparatus that converts the alternating into direct current is not one machine with two commutators, i. e., a rotary converter, but is a "motor generator," or two distinct dynamo electric machines on one base. The alternating current motor in this combination is driven by the current received from the transformers and revolves, by direct connection on the same shaft, the armature of the generator that furnishes the direct current. This is, however, but a detail of operation.

General statistics of substation equipment.--The number and horsepower of transformers, storage battery cells, rotary converters, and miscellaneous equipment in substations were required to be reported separately. It should be understood that none of this apparatus is in addition to the capacity of the generating plant, but is simply required in order to render the current available to the consumer. Tables 75 and 85 present in detail this class of equipment in private and municipal stations, respectively, by states and territories. The totals are summarized in the following table:

TABLE **60.**—*Substation equipment—private and municipal stations: 1902.*

KIND OF EQUIPMENT.	TOTAL.		PRIVATE STATIONS.		MUNICIPAL STATIONS.	
	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.
Storage battery cells	8,388	25,284	8,388	25,284	.....	.....
Transformers	1,800	419,367	1,765	418,068	35	1,299
Rotary converters	169	109,556	168	109,546	1	10
Miscellaneous	140	21,443	135	21,269	5	174

Storage batteries.—It will be seen by the table that in substations there were 8,388 storage battery cells, with a capacity of 25,284 horsepower. All of these were reported as in substations, and the presumption is, therefore, that they were so located, although there were in addition 6,881 cells, with a nominal capacity of 16,355 horsepower, reported as performing a kindred function in the main power plants. This gives a total of 15,269 storage batteries, with a capacity of 41,639 horsepower. The capacity of storage batteries can not be taken absolutely, since the horsepower depends so largely upon the rate of discharge, but the figures here given are such as are justified by the reports from the central stations as to battery output of current, although it was not found feasible to reduce this to horsepower hours. All of these storage batteries were in private stations, there being none whatever in municipal stations except in New York, where 900 cells of 20 horsepower capacity were reported. While the storage battery equipment was in no sense an addition to the generating capacity of the main power plants, its employment virtually increased such capacity by enabling a station to supply for a given period more current than it could actually generate in the same time, although such a period would be relatively short, often not more than a few minutes.

By far the largest number of storage battery cells, 2,616, was returned for New York, but their capacity was reported as only 2,240 horsepower. The average capacity of these cells is small as compared with that of the 950 in California, with 2,333 horsepower; the 912 in Illinois, with 5,590 horsepower; the 866 in Massachusetts, with 5,200 horsepower; the 476 in Missouri, with 1,955 horsepower; and the 166 in Ohio, with 1,333 horsepower. The capacity differed very remarkably, as a result of the variations in the rate of discharge and the different methods of calculating the available capacity or output of cells.

Transformers.—There were 1,800 substation transformers, with a total of 419,367 horsepower, and of these only 35, with 1,299 horsepower, were in municipal substations.

The transformers in private substations numbered 1,765, with 418,068 horsepower. They were widely distributed. California reported 504, with 139,527 horsepower, and New York 424, with 133,249 horsepower. In none of the other states do the number and capacity call for particular notice. In some of the states the transformers in the substations delivered alternating current at the lower pressures directly to the consumption circuits, without rectifying it into direct current by means of rotary converters or motor generators.

Other apparatus.—There were 169 rotary converters with 109,556 horsepower, and all of these except one of 10 horsepower were reported by private stations. The miscellaneous equipment enumerated in the table comprised 140 pieces of apparatus, with 21,443 horsepower, of which all but 5, with 174 horsepower, were in private stations. This miscellaneous apparatus consisted chiefly of the motor generating sets already referred to or of boosters, a type of direct current apparatus employed to keep the voltage of current up to a given point at places where, because of the distance from the main station, it might fall below the desired pressure.

Most of the 168 rotary converters reported for private stations were in five states, namely, 74 in New York, with 80,884 horsepower capacity; 23 in Pennsylvania, with 4,286 horsepower; 19 in Illinois, with 5,470 horsepower; 12 in California, with 4,858 horsepower; and 11 in Minnesota, with 3,066 horsepower. The miscellaneous apparatus reported was also largely confined to these same states.

Table 85 for municipal stations includes very little substation apparatus and that almost entirely in the transformer class. The 35 transformers with 1,299 horsepower were distributed among 10 of the states, chiefly in California, Michigan, and Vermont.

In the main power plants no enumeration was made of raising transformers, employed for the purpose of receiving alternating current at low pressure immediately from the adjacent generator and raising or stepping-up its pressure for better transmission over long distance circuits. This class of apparatus would, therefore, appear to be limited to what are specifically power plants, as distinguished from regular electric lighting and power stations working at much lower voltages than those which have become common in purely power transmission enterprises.

II.

LINE CONSTRUCTION.

General discussion.—A leading element in central station work is that of line construction, comprising the circuits that stretch overhead or underground between the central station, its substations, and the scattered consumers in the territory served. It is somewhat difficult to cover this item in full detail, and very careful efforts were made to obtain accurate reports. A feeder wire is one leading from the generating plant to a point where it is connected with the main wires; these wires in turn lead to the service wires to which are attached the lamps, motors, etc., consuming the current. The mains and feeders, in most instances, are not ordinary wires, but large and substantial cables made up sometimes of several strands or conductors of copper and sometimes of massive copper rod.

Statistics and ownership of mains and feeders.—An attempt to enumerate the service wires would have led to inextricable confusion and to great uncertainty of results, as it might be questioned whether many companies have any accurate idea as to the miles of service wire to which their mains and feeders may be connected within buildings; hence, the inquiry was limited to mains and feeders, the totals being summarized in the following table:

TABLE 61.—*Miles of electric line construction—private and municipal stations, and percentage each class is of total: 1902.*

	Total.	Private stations.	Municipal stations.	PER CENT— In private stations.	PER CENT— In municipal stations.
Total:					
Mains	107,263.63	93,352.95	13,910.68	87.0	13.0
Feeders	17,880.51	16,452.28	1,428.23	92.0	8.0
Underground—					
Mains	5,847.71	5,408.55	439.16	92.5	7.5
Feeders	2,276.55	2,262.02	14.53	99.4	0.6
Overhead[1]—					
Mains	101,383.76	87,913.13	13,470.63	86.7	13.3
Feeders	15,592.59	14,181.75	1,410.84	91.0	9.0
Submarine—					
Mains	32.16	31.27	0.89	97.2	2.8
Feeders	11.37	8.51	2.86	74.8	25.2

[1] Includes 79.50 miles of mains and 120.25 miles of feeders for electric railway service owned by lighting company.

In this table the circuits are divided into three groups—overhead, underground, and submarine. With the overhead mains and feeders are included the circuits for electric railway service owned by lighting companies. Generally such wires are owned by the railway companies, and therefore the mileage for them embraced in this table is small. The underground conduits are frequently owned by the lighting companies, but there are some instances in which they are owned by a separate conduit company, as in New York, or by the municipality, as in Chicago. In these cases the lighting companies pay a rental for the use of the ducts through which their mains and feeders are drawn, and the amount paid out for this accommodation forms an important addition to the price that must be charged for the service in order to cover such items of expense. The special agents were required, therefore, to obtain a complete statement from lighting companies on these points, showing rental paid for conduits, and thus elicit the facts as to ownership.

There were 125,144.14 miles of mains and feeders reported for both private and municipal stations. Of this total 107,263.63 miles were returned as mains and 17,880.51 miles as feeders, the ratio being about 1 mile of feeder to 6 miles of main. Of the grand total 109,805.23 miles, or 87.7 per cent, were reported by private stations and 15,338.91 miles, or 12.3 per cent, by municipal stations. The mains and feeders for underground circuits measured 8,124.26 miles, or 6.5 per cent of the total, and the overhead circuits including 199.75 miles of mains and feeders for electric railway service owned by the central lighting stations, measured 116,976.35, or 93.5 per cent of the total.

Table 61 includes also the figures for both private and municipal stations, from which it will be seen that while the municipal stations had but 7.5 per cent of the underground mains and only six-tenths of 1 per cent of underground feeders, they had 13.3 per cent of the overhead mains and 9 per cent of the overhead feeders. It thus appears that it is the municipal, rather than the private, stations that have the larger proportion of overhead circuits to which such strenuous public exception is often taken, but, on the other hand, it must be borne in mind that nearly all of the municipal stations are in the smaller communities where the cost of underground work makes the use of the underground system impossible, and where, as a matter of fact, neither wires nor poles constitute a particular blemish to the landscape.

Line construction, by states and territories.—Tables 73 and 83 give details, by states and territories, as to the distribution of these main and feeder circuits for private and municipal stations, respectively. Of the 16,452.28 miles of feeders connected to private stations, 1,932.80 were in use in the state of New York and 2,949.28 miles in Pennsylvania. The mileage of the mains in New York and Pennsylvania did not differ greatly, being 11,139.17 miles in the former and 11,382.01 miles in the latter. In Massachusetts there were 962.38 miles of feeders and 11,415.55 miles of mains. In Illinois there were 876.68 miles of feeders and 5,374.80 miles of mains. Rhode Island ranked third in mileage of feeders, with 1,086 miles, but had only 2,593.50 miles of mains, the relative proportion of mains to feeders being extraordinarily small, or only 2 to 1, while the ratio for the whole country was about 6 to 1.

The relative extent of overhead and underground circuits in the different states varied, being determined somewhat by the practice in a few of the larger cities. Thus in New York there were 303.12 miles of feeders and 1,325.11 miles of mains in the underground circuits, while for Massachusetts there were reported only 17.55 miles of underground feeders and 1,657.83 miles of underground mains. In Pennsylvania, on the other hand, the amounts of the two underground varieties were more nearly equal, being 500 miles for feeders and 668.50 miles for mains. Pennsylvania was the state with the largest extent of overhead main and feeder circuits, namely, 2,424.28 miles of feeders and 10,699.51 miles of mains. New York came next as to overhead circuits with 1,626.78 miles of feeders and 9,769.06 miles of mains. It was closely followed by Massachusetts with 936.83 miles of feeders and 9,757.55 miles of mains. More than half of the states did not report any underground mains or feeders, but this fact is only confirmatory of the statement already made as to the limiting of underground work to the relatively few larger cities. Even the states enumerating underground work have, as will be seen from the table, very large amounts of overhead construction.

While the underground work of municipal stations was limited to five states it was found almost exclusively in Illinois and Michigan, the former having 367.50 miles of mains and 6.03 miles of feeders, and the latter having 49.16 miles of mains and 7.50 miles of feeders. These figures are large because of the municipal stations in Chicago and Detroit. Of the aggregate mileage for municipal stations, Michigan had the largest proportion, which was slightly more than that of Illinois. There were in Michigan 1,980.74 miles of mains and 140.34 miles of feeders, while in Illinois there were 1,990.75 miles of mains and 104.77 miles of feeders.

Very little submarine circuit was reported, there being 11.37 miles of feeders and 32.16 miles of mains. The largest item is that of the 18.1 miles for private stations in Illinois, the greatest part or all of which would probably be found employed at various points very close to the Chicago river.

III.

SERVICE LINE EQUIPMENT.

Transformers.—Between the power plant or the substation and the apparatus at the consumption points are frequently to be found either transformers or meters, or both. Where the current used is "direct," transformers are not necessary, but where the current delivered to the premises is of the alternating type a transformer is required, in order to bring the current pressure down to the point at which it can be conveniently and safely used. These transformers are sometimes located within the consumers' own premises, but quite frequently they are placed upon an adjacent pole, which thus serves as an embryo substation for the distribution of current not merely to one house but to a group of houses. These transformers range in size from those able to deliver current for 10 lamps to those which will receive and transform the current for scores of lamps and long circuits.

Transformers of private stations.—It will be seen from Table 75 that there were 179,300 transformers, with a total capacity of 820,968 horsepower, in use on consumers' circuits connected to private stations. This gives an average of 4.6 horsepower to the transformers, making the average capacity from 75 to 100 lights.

In the earlier stage of alternating current work, smaller transformers were in service quite generally, but of late years they have decreased in number, while the capacity of the newer ones has risen rapidly.

The statistics, by states, present some variations in this respect. The reports for New York, for example, showed 17,009 transformers with a capacity of 186,031 horsepower, or an average of more than 10 horsepower per transformer. In Kentucky, Pennsylvania, Texas, Rhode Island, and Colorado the average was below 3 horsepower per transformer, showing beyond question the continued use of a large number of the small sizes. In Illinois, Massachusetts, Ohio, and New Jersey the average horsepower per transformer was about 4. The use as indicated by these figures and others in the table of so many small transformers is regarded as a practice making against efficiency and economy, and the whole tendency of recent years has therefore been to adopt larger types, although where the circuits are widely distributed and the customers are few, the small transformer is an absolute necessity. The installation of more than 20 or 30 lights in an ordinary dwelling house would be unusually large, and the individual wants of many houses would be amply taken care of with a transformer of a single horsepower capacity.

Transformers of municipal stations.—It will be seen from Table 85 that the municipal stations reported that there were 28,070 transformers with 100,106 horsepower capacity on their consumers' circuits. The average per transformer was 3.6 horsepower and therefore was considerably less in most municipal stations than in the private stations. An inspection of the table, by states and territories, shows that the largest number of transformers was in Ohio, where the average capacity was slightly over 3 horsepower. The average in Michigan also was a little more than 3 horsepower, while that in Indiana was a little less. The average capacity of municipal transformers in many states was very low. For Colorado, the reports showed 60 transformers and only 84 horsepower; in New Hampshire, 35 with 75 horsepower; in Utah, 37 with 67 horsepower; and in West Virginia, 71 with 130 horsepower. These are states, however, in which the conditions would usually require scattered circuits and isolated points of consumption of small sizes, necessitating the use of smaller transformers.

Classification of meters.—Meters are employed for both the direct and alternating classes of current and are now in almost universal use, although it is still the practice in some communities to sell current on a flat basis, the number of lamps and an assumed number of hours of burning being used as criteria in fixing the amount of the monthly bill. It is not the custom to employ these meters in connection with arc lighting whether the lights are for street or for commercial purposes. For this investigation the meters were divided into two main classes—mechanical and chemical. The former is intended to cover all meters in which the current effects registration by actuating electro-mechanically an escapement or train of gear wheels. In the chemical class, once largely prevalent but now seldom used, a deposit of metal is usually effected on a small scale by the action of the current, and the amount of current used is ascertained by weighing month by month the metal deposited. The later indications are that some forms of chemical meters are coming into vogue again.

Table 62 shows the number of meters on consumers' circuits reported for all stations, and also the number and proportion of each kind of meter for private and municipal stations, respectively.

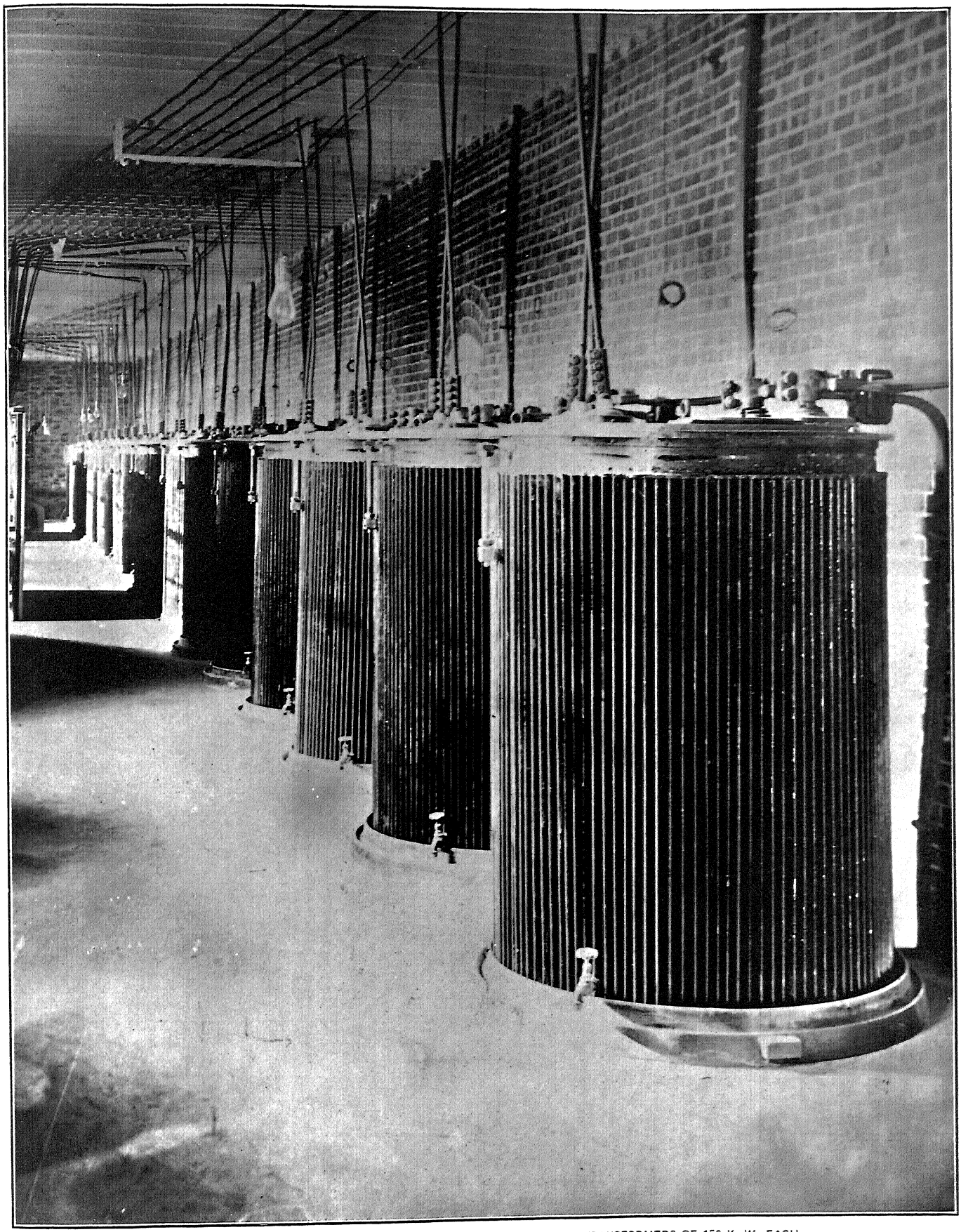
TABLE 62.—*Meters on consumers' circuits—private and municipal stations, and percentage each class is of total: 1902.*

KIND OF METER.	Total.	PRIVATE STATIONS.		MUNICIPAL STATIONS.	
		Number.	Per cent.	Number.	Per cent.
Total	582,689	526,011	90.3	56,678	9.7
Mechanical	575,004	518,428	90.2	56,576	9.8
Chemical	7,685	7,583	98.7	102	1.3

It will be seen from the table that the mechanical meters are in general use, inasmuch as 575,004 or 98.7 per cent of all meters in both private and municipal stations were mechanical and only 7,685 were chemical. The statistics for these meters are given, by states and territories, in Tables 75 and 85 for private and municipal stations, respectively.

Meters in private stations.—For private stations in New York 70,491 mechanical meters were reported, of which by far the largest number were in use in New York city. The New York Edison Company alone had some 30,000 customers in 1902–3, each of whom would be supplied with a meter. In fact, leaving arc lighting patrons out of consideration, a rough assumption not far from the truth might be made that each meter represented a customer, although in some cases a single consumer may use more than one meter when furnished with different classes of service. Pennsylvania reported 54,198 mechanical meters; Illinois, 53,584; Massachusetts, 52,137; California, 33,308; Ohio, 25,083; Michigan, 21,160; and New Jersey, 20,830. In most of these figures the influence of the larger centers of population with numerous customers is seen. The chemical meters connected to private stations were limited to 10 states, and were to be found almost entirely in Illinois, New York, and Pennsylvania, representing without question the chemical meters still employed by the Edison systems in the cities of Chicago, New York, and Philadelphia.

Meters in municipal stations.—The meters connected to municipal stations numbered 56,678, of which all but 102 were mechanical. The 102 chemical meters were



TYPICAL TRANSFORMER, SHOWING AN EQUIPMENT CONTAINING 22 TRANSFORMERS OF 150 K. W. EACH.

reported from one state, Indiana. The mechanical meters were widely distributed, the large numbers being found in the following states: Michigan, 7,712; Ohio, 6,001; Minnesota, 5,606; and Indiana, 5,603. The use of meters follows quite closely the distribution of incandescent lighting from municipal stations in the various states referred to.

Lighting apparatus.—At the time the statistics of the present report were compiled the apparatus attached to central stations for lighting purposes consisted broadly of two classes, namely, arc lamps and incandescent lamps.

General statistics of arc lamps.—Tables 76 and 86 show the number of arc lamps of each type, wired and ready to render service, for private and for municipal stations, respectively. The totals are summarized in Table 63, which also shows for each variety of lamps the proportion for both private and municipal stations.

TABLE 63.—*Number of arc lamps—private and municipal stations, and percentage each class is of total: 1902.*

CHARACTER OF SERVICE AND KIND OF LAMP.	Total.	PRIVATE STATIONS.		MUNICIPAL STATIONS.	
		Number.	Per cent.	Number.	Per cent.
Aggregate	385,698	334,903	86.8	50,795	13.2
Commercial or other private, total	173,973	168,180	96.7	5,793	3.3
Open	42,988	41,622	96.8	1,366	3.2
Inclosed	130,985	126,558	96.6	4,427	3.4
Direct current	104,176	101,849	97.8	2,327	2.2
Open	38,120	36,856	96.7	1,264	3.3
Inclosed	66,056	64,993	98.4	1,063	1.6
Alternating current	67,538	64,085	94.9	3,453	5.1
Open	3,733	3,631	97.3	102	2.7
Inclosed	63,805	60,454	94.7	3,351	5.3
All other	2,259	2,246	99.4	13	0.6
Open	1,135	1,135	100.0	.....	.....
Inclosed	1,124	1,111	98.8	13	1.2
Public, total	211,725	166,723	78.7	45,002	21.3
Open	138,684	108,082	77.9	30,602	22.1
Inclosed	73,041	58,641	80.3	14,400	19.7
Direct current	154,749	119,520	77.2	35,229	22.8
Open	125,298	96,659	77.1	28,639	22.9
Inclosed	29,451	22,861	77.6	6,590	22.4
Alternating current	48,063	38,316	79.7	9,747	20.3
Open	4,630	2,681	57.9	1,949	42.1
Inclosed	43,433	35,635	82.0	7,798	18.0
All other	8,913	8,887	99.7	26	0.3
Open	8,756	8,742	99.8	14	0.2
Inclosed	157	145	92.4	12	7.6

The aggregate of arc lamps of all classes was 385,698, of which 334,903, or 86.8 per cent, were operated from private stations and 50,795, or 13.2 per cent, from municipal stations. In addition to these 385,698 arc lamps connected to the circuits of central stations, the street railways operating electric lighting stations reported 33,863 arcs, making the total for the United States 419,561. This does not include, however, a large number of arcs operated in isolated plants of all kinds—a number which is estimated by some authorities to be almost equal to the number operated on central station circuits. As has already been pointed out in the discussion of income, the annual earnings of arc lighting by central stations were $27,408,708, giving an average of $65.33 per lamp, regardless of daily hours of burning. There were on an average about 155 lamps connected to each private station. The arc lamps connected or supplied by municipal stations averaged a little over 62 per station. As will be seen, however, there were comparatively few commercial lamps furnished by municipal stations, while the private stations did a large business of this character. Thus the private stations had connected to their circuits 168,180 commercial arcs and 166,723 public arcs, the business being very nearly equally divided. On the other hand, the municipal stations furnished only 5,793 commercial arcs, while they operated 45,002 public arcs. Altogether 173,973 arcs were for commercial service and 211,725 were for public service, the proportion being, respectively, 45.1 per cent and 54.9 per cent.

Classification of arc lamps.—The arc lamps are subdivided into those of the open type and those of the inclosed type, and also into those operated by direct current and those operated by alternating current. Until quite recently all the arc lamps in use in the country were of the open type, that is, they were inclosed by only one large globe. The characteristic of the inclosed type is the presence of a large outer globe and a small inner globe constituting a semivacuum immediately around the carbon sticks. Until recently this type was quite unknown in practical service, although it had been experimented with at the beginning of the industry. Since these statistics were compiled the tendency toward the production of inclosed arcs to the exclusion of the open arcs has been pronounced and intensified, and very few open arcs are now made. The transition was already so well marked in 1902 that 204,026, or 52.9 per cent, of the lamps in use were even then of the inclosed type, while 181,672, or 47.1 per cent, were of the open variety. While this change has been going on it has been accompanied by a corresponding resort to the alternating current for arc lighting work. Of the total number of arc lamps, 258,925 lamps, or 67.1 per cent, were operated by direct current, and 115,601, or 30 per cent, were operated by alternating current. It is interesting to note that while the inclosed lamps preponderated largely in commercial work, the open type was still signally in the majority for public lighting. Thus of the commercial lamps 130,985 were inclosed and 42,988 were open. On the other hand, 73,041 of the public lamps were inclosed and 138,684 were open. Of the arc lamps operated from stations controlled by electric railway companies 13,450 were of the open type and 20,413 of the inclosed.

It will be observed that a small number, 11,172, of all other lamps were returned, of which all but 1,281 were of the open type. These were difficult to classify, and probably under a strict classification all of them would have been returned as commercial lamps. They were not, however, used for illuminating purposes, according to the strict understanding of the word, but included a great many focusing and projector lamps used in theaters for stage projection purposes, in

photographic studios, engravers' shops, and in daily newspaper offices for the quick production of photographs, engravings, etc. These lamps would earn a larger income and in many instances would be much larger than the ordinary arc lamp, but it was deemed proper not to include them with arcs used strictly for illumination of buildings, streets, etc. A great many such special lamps were also employed on the circuits of isolated plants, but only those are included that were operated by central station circuits.

Arc lamps of private stations.—Table 76 shows, by states and territories, the number of arc lamps of each type connected to the circuits of private stations.

The proportions as to commercial and public lighting varied in the different states. In New York there were 30,608 public and 26,697 commercial lamps. In Pennsylvania there were 18,332 commercial and 25,851 public lamps. In Illinois, on account of the municipal stations in Chicago, the business was less evenly divided, there being only 9,636 public lamps, while the commercial lamps numbered 18,678, or nearly twice as many. In Massachusetts the numbers were almost equal, there being 14,658 public and 12,401 commercial lamps. No particular indication or information is derivable from these variations so far as individual states are concerned, and the conditions would doubtless be found to vary with individual stations rather than with territorial divisions, since so much depends upon the attitude of the management in any station with regard to particular branches of the business. In many of the larger cities the public arc lighting had diminished to a very small part of the business, and no particular activity was put into the canvass for commercial arc lighting. In other communities the arc lamp was held in special favor and its interests were pushed actively. It is to be further observed that in almost all of the states the direct current arc was in use, while the alternating current arc was less generally favored and, where in use, was very largely of the inclosed type, as, for example, in New York, Pennsylvania, Illinois, California, Massachusetts, and Ohio. The lamps classed in the "all other" group were limited to a few states, the principal ones being New York, California, New Jersey, Ohio, Pennsylvania, and Michigan.

Arc lamps of municipal stations.—The analysis of the 50,795 arc lamps reported by municipal stations is shown, by states and territories, in Table 86. There were 45,002 lamps used for public lighting and 5,793 for commercial lighting. The great proportion used for public lighting indicates how largely the municipal stations have adhered, so far as arc lighting is concerned, to their purpose of supplying public illumination to the disregard of commercial work. In fact, in several of the states no commercial arc lamps whatever were reported by the municipal stations, while in other states the number of such lamps was very small.

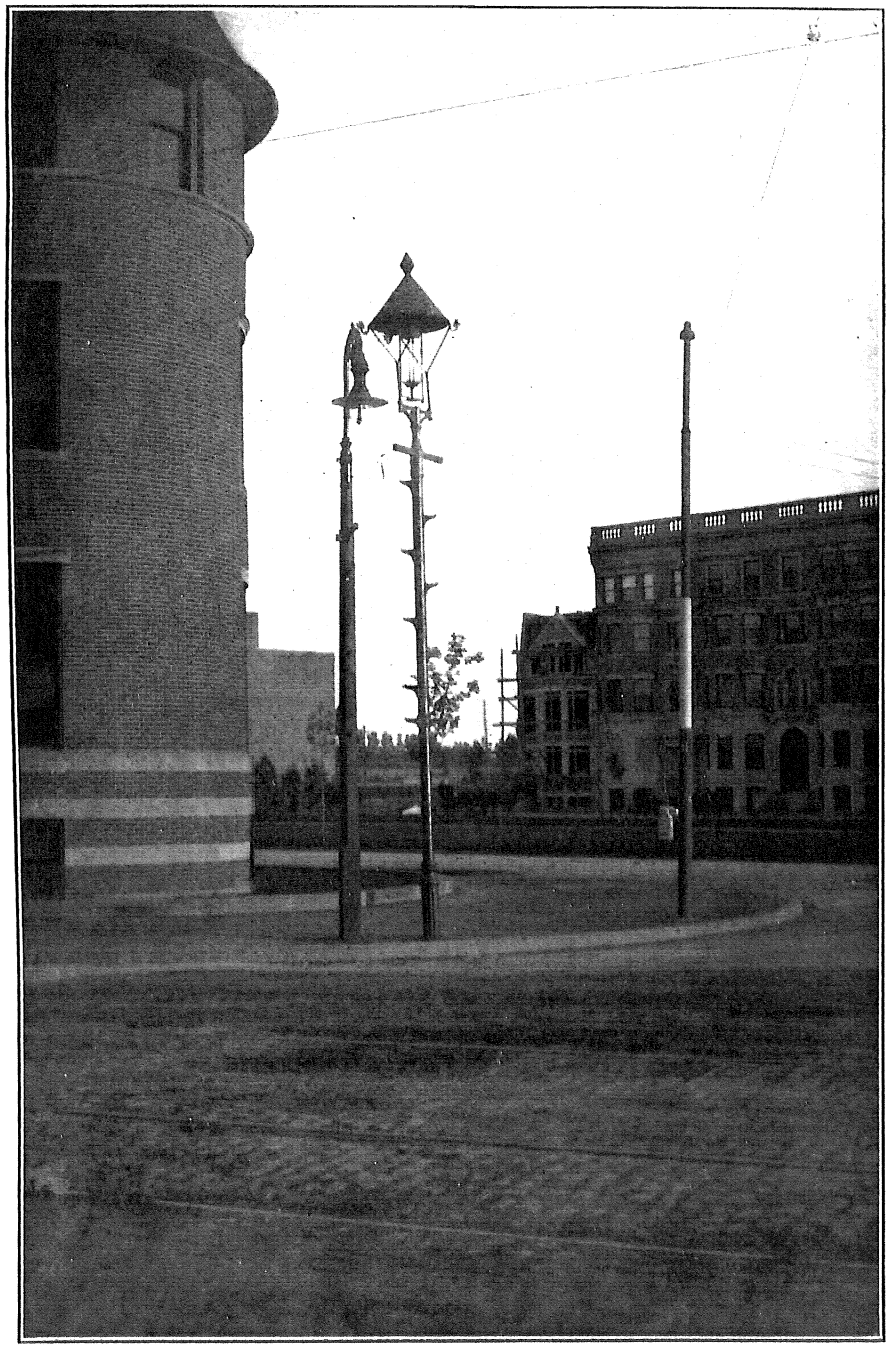
The fact that the arc lighting from private stations was done largely by inclosed arcs illustrates the rapid adoption of the latest improvements as well as an expensive discarding of old apparatus by such stations; on the other hand, the municipal stations experienced difficulty in adapting a public service plant to new conditions in an industry that was not yet well established as to its underlying technical conditions. When it is considered that such apparatus represents the investment of public money and is usually operated at a very low allowance for depreciation, as well as on a basis of return which frequently proves inadequate, it will be understood why in so many of the municipal stations the apparatus, whether for the production of current or for its consumption, remains antiquated. Of the 45,002 public lamps 30,602 were of the open type and 14,400 of the inclosed type. Of the lamps in Illinois only 1,427 were inclosed, while 8,361 were of the open type. In Michigan 2,202 were inclosed and 4,027 were of the open type.

Another illustration of the difficulty experienced by municipal stations in changing to more recent apparatus is furnished by the figures of the alternating current arcs, of which there were only 13,200, or a little over one-fourth of the total number for municipal stations, whereas the private stations reported 102,401 out of an aggregate of 334,903, or nearly one-third of the total. In several of the states, however, the change had already been made to a considerable extent, as, for example, in Tennessee out of 971 lamps 806 were of the alternating current type, and in Washington 897 out of 967 were alternating. These figures would appear to be due to the fact that the stations included were new and had been more recently equipped, thus affording the municipal plants the opportunity of starting out with apparatus of approved modern type.

Arc lamps of stations, classified according to population of places in which located and dynamo capacity.—Tables 87 to 90 show the statistics of arc lamps in stations, classified according to population of places in which located. In the purely electric private stations the number of lamps increases as the population groups increase in size. Of those used for commercial lighting almost three-fourths were of the inclosed type, while of those used for public lighting almost two-thirds were of the open type. These figures bring out rather forcibly the slow changes in public property and the practice of the private stations to keep up with the times. The same general conclusions are drawn from Tables 88, 89, and 90.

In Tables 91 to 94 are given the number of lamps in stations, classified according to the horsepower capacity of dynamos. Of the arc lamps in purely electric private stations almost one-half were connected with stations having a dynamo capacity of 5,000 horsepower and over. In the municipal stations nearly all the lamps were found connected to the small stations.

General statistics of incandescent lamps.—The most



MODERN METHODS OF STREET LIGHTING, BOSTON, MASSACHUSETTS.

In this engraving open and inclosed arc lamps are shown side by side on different types of poles.

METHOD OF LIGHTING FIFTH AVENUE, NEW YORK CITY.

In this view, near the Waldorf Astoria Hotel, New York city, direct current multiple inclosed arc lamps are shown, two on each post, and directly connected by underground circuits with the mains and feeders which also serve current to residences.

productive source of income for American central stations is the furnishing of current for incandescent lighting. In preceding tables it was shown that out of a total income of $85,700,605, incandescent lighting amounted to $44,657,102, or 52.1 per cent. For private stations the rate was 52.5 per cent, and for municipal stations 48.2 per cent. This income was earned by a total of 18,194,044 incandescent lamps. This total may be accepted as a close approximation to the actual number of lamps wired and ready for use at the end of the year covered by this report. The central station industry of the country, so far as service for incandescent lamps is concerned, is now very largely on a meter basis, and this renders it difficult to secure a record of the actual number of incandescent lamps in service. In many cases the numbers reported, therefore, were estimates, but these estimates would not vary widely from the actual numbers, and would be rather an understatement than an exaggeration. Table 64 gives a summary of the totals for the United States and shows the proportions of incandescent lamps connected to private and to municipal stations.

TABLE 64.—*Number of incandescent lamps—private and municipal stations, and percentage each class is of total: 1902.*

CHARACTER OF SERVICE AND KIND OF LAMP.	Total.	PRIVATE STATIONS.		MUNICIPAL STATIONS.	
		Number.	Per cent.	Number.	Per cent.
Aggregate	18,194,044	16,616,593	91.3	1,577,451	8.7
Commercial or other private, total	17,738,384	16,243,853	91.6	1,494,531	8.4
16 candlepower	15,261,067	13,890,281	91.0	1,370,786	9.0
32 candlepower	514,679	484,246	94.1	30,433	5.9
All other candlepower	1,962,638	1,869,326	95.2	93,312	4.8
Public, total	455,660	372,740	81.8	82,920	18.2
16 candlepower	296,776	235,842	79.5	60,934	20.5
32 candlepower	59,988	47,063	78.5	12,925	21.5
All other candlepower	98,896	89,835	90.8	9,061	9.2

Of the total number of incandescent lamps of all varieties 16,616,593, or 91.3 per cent, were reported for stations under private ownership, and 1,577,451, or 8.7 per cent, were reported on the circuits of the municipal stations. Of the lamps connected to private stations 16,243,853, or 97.8 per cent, were employed in commercial lighting and 372,740, or 2.2 per cent, in public lighting. Of the 1,577,451 lamps reported for municipal stations 1,494,531, or 94.7 per cent, were employed in commercial lighting and only 82,920, or 5.3 per cent, in lighting streets, parks, public buildings, etc. The earlier municipal stations were started primarily with the object of furnishing arc lighting for street illumination, but these figures show the remarkable extent to which a deviation has been made from the original purpose. It is also deserving of notice that of the 455,660 lamps in public use 296,776, or nearly two-thirds, were of 16 candlepower and 59,988 were of 32 candlepower. While the great majority of 32-candlepower lamps were undoubtedly in use for street lighting it would appear that a very large proportion of the 16-candlepower lamps were in use for purposes other than out-of-door work.

The lamps of all other candlepower, 2,061,534 in number, comprise small lamps of from 4 to 8 candlepower, chiefly for advertising and decorative purposes, and a comparatively small number of lamps of high candlepower, such as 50 candlepower. In addition to all these lights, there were connected to the electric light and power stations operated by street railways a total of 1,442,685 incandescent lamps, of which 1,423,659 were in commercial use and 19,026 were employed for public lighting. The large majority of these, 1,326,368, were of 16 candlepower.

Incandescent lamps of private stations.—The private stations reported an aggregate of 16,616,593 incandescent lamps, of which 13,890,281 in commercial or other private use, and 235,842 in public use were of the 16-candlepower type. Exact figures were not obtainable on the point, but it is considered by many authorities that aside from decorative lamps there is a steady diminution in the demand for those of other candlepowers, such as 32 and 50, leaving the 16 candlepower as the unit of almost universal adoption and employment. In this connection it may be noted that in Europe, while the 16-candlepower lamp is well known and in widespread use, lamps of from 8 to 10 candlepower are largely employed—to such an extent, indeed, that it is still a common practice to estimate lighting capacity on the basis of 8-candlepower lamps. Throughout the United States, however, the 16-candlepower lamp is universally acknowledged as the standard, and it is questioned whether any of smaller candlepower are in regular commercial or public use for lighting purposes. None were disclosed by this investigation.

Of the 13,890,281 16-candlepower lamps in commercial use, 2,230,905, or almost a sixth, were in use in New York. The next largest number was 1,431,129 in Pennsylvania, followed by 1,377,619 in Illinois and 1,286,837 in Massachusetts. Other large figures were 921,136 in California, 527,422 in New Jersey, 720,162 in Ohio, 500,566 in Missouri, 476,074 in Michigan, and 451,928 in Indiana.

The effect can be traced in these figures generally, of the large centers of population, such as New York, Philadelphia, Chicago, Boston, Detroit, Cleveland, and Cincinnati. Incandescent lamps were to be found in every state of the Union, but, in spite of their wide distribution, very few were reported for some localities. Thus only 7,871 16-candlepower lamps were reported for Nevada, 12,498 for Indian Territory, 17,896 for Wyoming, 18,233 for Oklahoma, and 21,722 for New Mexico.

The public incandescent lamps of 16 candlepower were also widely distributed, but numbered only 235,842.

Of these 93,229, or more than one-third, were in New York, 17,299 in Illinois, 15,520 in Ohio, 14,031 in Pennsylvania, and 10,345 in California.

The number of 32-candlepower lamps in use with private stations was 531,309, of which 484,246 were commercial and 47,063, public. Of the commercial lights of this size, 173,232, or slightly more than one-third, were in New York state. This number was strikingly larger than that reported for any other state. The figures for New Jersey were 58,316 and those for Pennsylvania, 41,867. These three states accounted for 273,415 lamps. In some states very few lamps of this size were in use, either for commercial or public purposes; while in some other states their use in proportion to the total number of incandescent lamps was much more marked. Thus, in Indiana, out of a total of 522,118 incandescent lamps, 8,437 were of 32 candlepower, but in Iowa, out of 343,346, no fewer than 17,266 were of that capacity.

With regard to lamps of all other candlepower, of which there were 1,869,326 in commercial use and 89,835 in public use, the number in New York state was greater than that in any other state. In fact, out of the total of 1,959,161 for the United States, 1,140,769, or nearly two-thirds, were in New York. The next largest number reported, 239,784, was for Pennsylvania, but in no other state did the total reach 100,000.

Incandescent lamps of municipal stations.—Table 86 gives an analysis of incandescent lighting from municipal stations, by states and territories. It has already been pointed out that with the municipal stations incandescent lighting service is far more general than has been supposed. Of 815 municipal stations, 602 reported incandescent lighting for public purposes and 732, for commercial purposes. There was a total of 1,577,451 incandescent lamps connected to the municipal stations. Of these lamps, 1,431,720 were of the 16-candlepower type, 1,370,786 being commercial and 60,934, public. These lamps were so widely distributed that no very large numbers were reported from any state.

Of the 43,358 lamps of 32 candlepower, 30,433 were commercial and 12,925, public. A very large proportion was reported from Michigan, namely, 5,689 commercial and 614 public, Iowa coming next with 4,767 and 1,483, respectively. The totals in Illinois were 2,002 commercial and 2,119 public, and in Minnesota, 2,911 and 1,116, respectively. As to the lamps of all other candlepower, out of a total 93,312 commercial and 9,061 public, a very large proportion was again reported for Michigan, namely, 25,796 commercial and 290 public. Of both the 32 candlepower and the all other candlepower classes, Massachusetts reported very few commercial lights, but in public lighting the conditions were reversed, there being 1,207 public lamps of 32 candlepower and 1,543 of all other candlepower—presumably 50 candlepower. In many of the states no lamps of the "all other" class were in use, and in many other states the numbers were quite insignificant.

Incandescent lamps of stations, classified according to population of places in which located.—In Tables 87 to 90 are shown the number of the different varieties of incandescent lamps connected to central stations, classified according to the population of the places in which they are located. These tables show the comparatively large proportion of these lamps in the small towns and cities. Thus in the purely electric private stations 2,383,717 lamps out of a total of 11,463,050 were in places of less than 5,000 inhabitants, while in the stations operated in connection with other business this group had one-fifth of the total.

Use of stationary motors.—The third great class of apparatus to which electric current is now supplied is that of the stationary power motors, which were reported separately in the schedule of 1902. Stationary motors include all power motors that are permanently located at one point, as distinguished from electric railway motors on cars.

In the compilation of these statistics it was the intention to exclude all motors used for the operation of fans, since they are extremely small, averaging perhaps a tenth of a horsepower, but it is probable that some of these fan motors were included in the returns. Stationary motors are used for a great variety of work, and range in capacity from a fraction of a horsepower to several hundred horsepower. Some of the motors furnish power for the operation of ventilators, elevators, hoisting apparatus, machines, etc. In some instances the motors are attached to a line shaft, and drive the machinery of whole floors of a factory or a machine shop, while in other instances they are connected to single and separate appliances. It would be hard to mention a trade in which motive power is used, for which part of the motive power is not now supplied by electricity.

At the outset of the industry, none of the central stations carried motors on the circuits. Then a few of the series type were introduced on the high potential arc lighting circuits, and one or two power companies were formed which put in operation low voltage direct current motors in parallel, and endeavored to build up a business simply and solely on the power basis. When it was demonstrated that these low voltage parallel motors were a success, and it was shown that they could be operated on incandescent lighting circuits without causing serious fluctuations in the current supplied to the lights, the central stations with incandescent lighting circuits took them up eagerly, so that in 1902 virtually the whole of the stationary motor business of central stations was being done with low voltage incandescent lighting, 110 to 250 volt circuits, or on a few special power circuits with direct current of a pressure not exceeding 500 volts. In other words the old series motors on the arc lighting

circuits had almost entirely disappeared, and it was difficult to locate any of them, although it was understood that a few were still in use in one or two places.

General statistics of stationary motors.—As will be seen from Tables 76 and 86 there were connected to the central stations of the country 101,064 stationary motors, of a total capacity of 438,005 horsepower. Of these, 99,102, with a capacity of 434,681 horsepower, were reported as being in operation in connection with private stations, and 1,962, with a capacity of 3,324 horsepower, were reported as being in operation in connection with municipal stations. It was exceedingly difficult to ascertain the number of motors on the circuits, but careful estimates were obtained for each station, and the number and horsepower capacity given may be accepted as closely approximating the facts. Incidentally it may be noted that the number of railway cars served was 2,379, of which number all but 9 were reported by private stations.

Motors of private stations.—As shown by Table 76, which gives the figures, by states and territories, for private stations, the motors were quite generally distributed throughout the country, although a large proportion was limited to a few leading states. Thus New York reported 13,557 motors, with 109,195 horsepower. This number was exceeded in Pennsylvania, where there were 14,128 motors, but in this state the total capacity was very much less, being only 30,536 horsepower. In Illinois there were 11,828 motors, with 35,910 horsepower; in Massachusetts, 9,621, with 35,565 horsepower; in Ohio, 5,535, with 21,657 horsepower; in California, 5,112, with 49,856 horsepower; in Missouri, 4,552, with 14,411 horsepower; in New Jersey, 2,209, with 9,245 horsepower; in Indiana, 2,267, with 5,550 horsepower; and in Minnesota, 1,826, with 9,331 horsepower. It will be seen that the horsepower capacity of motors varied widely. Of the states having a large number of motors, the average capacity of between 9 and 10 horsepower, which was found in California, was the highest, although the motors in New York were not much smaller, having about 8 horsepower each. In Ohio the average was about 4 horsepower; in Illinois, 3 horsepower; and in Pennsylvania, 2 horsepower. As for the railway cars operating, by far the largest number, 919, was reported for Pennsylvania, other large numbers being 231 in California, 219 in Massachusetts, 180 in Illinois, and 131 in Ohio.

Motors of municipal stations.—Table 86 gives an analysis of the motor service of the municipal stations, by states and territories. As already noted, the number of motors was only 1,962, and the total capacity 3,324 horsepower. As a matter of fact, only 118 out of the 815 municipal stations were engaged in this class of work. The largest number of motors, namely, 364, was reported from Indiana, but the capacity of these motors was only 103 horsepower, the average being less than one-third of 1 horsepower each. In Louisiana there were 246 motors, but the total capacity was given as only 34 horsepower, which would lead one to infer that some of the motors were of the fan type. On the other hand, there were 232 motors, with 464 horsepower, in Michigan; 169 motors, with 299 horsepower, in Ohio; 78 motors, with 440 horsepower, in California; and 137 motors, with 280 horsepower, in Texas.

CHAPTER VI.

OUTPUT OF STATIONS.

Measurement of output.—The main function for which a central station exists is the generation of current, all other business being incidental. The electric light and power company may be regarded by itself and by the public as a merchant of illumination, and in the earlier days of the industry it was the policy as well as the practice of stations to limit themselves to the operation of arc and incandescent lamps and to reckon their income upon an arbitrary basis of a flat rate for the supplying of so many lamps for the day, week, month, or year. The larger stations, however, shifted rapidly and the smaller ones more slowly to the practice of computing their income and expenses on the basis of the generating output, and a very large proportion of the income dealt with in this report, while still related specifically to the number of arc and incandescent lamps or motors supplied, is computed and analyzed by the stations themselves on the unit of kilowatt hour output. The kilowatt hour is the unit now in universal acceptance and is 1,000 watts of current supplied for an hour. There are 746 watts in the old familiar horsepower, so that a kilowatt is about 1⅓ horsepower.

Some of the larger stations attempt with appropriate instruments of large caliber the exact measurement of all the current leaving their generating plants at every hour of the day and night. Others do not measure all the current, but base estimates of output upon occasional readings at the switchboard of volts and amperes and watts, or figure out the known consumption capacity of the apparatus supplied with current.

The fact that the current for arc lighting is not usually metered necessitated computations for a great many stations, but there are familiar units for such purposes, and a standard arc lamp is accepted as consuming from 450 to 550 watts per hour. In like manner it was necessary to estimate the consumption for many of the incandescent lamps, but this is a relatively easy process on the basis of an average consumption of 3.1 watts per candlepower per hour for ordinary standard incandescent lamps of 16 candlepower.

Loss of current in transmission.—It is needless to say that there is, and always will be, a certain difference between the output of current recorded on the station instruments and the consumption as indicated by the sales, and it is the steady endeavor of the station managements to determine and locate such intermediate loss so far as possible.

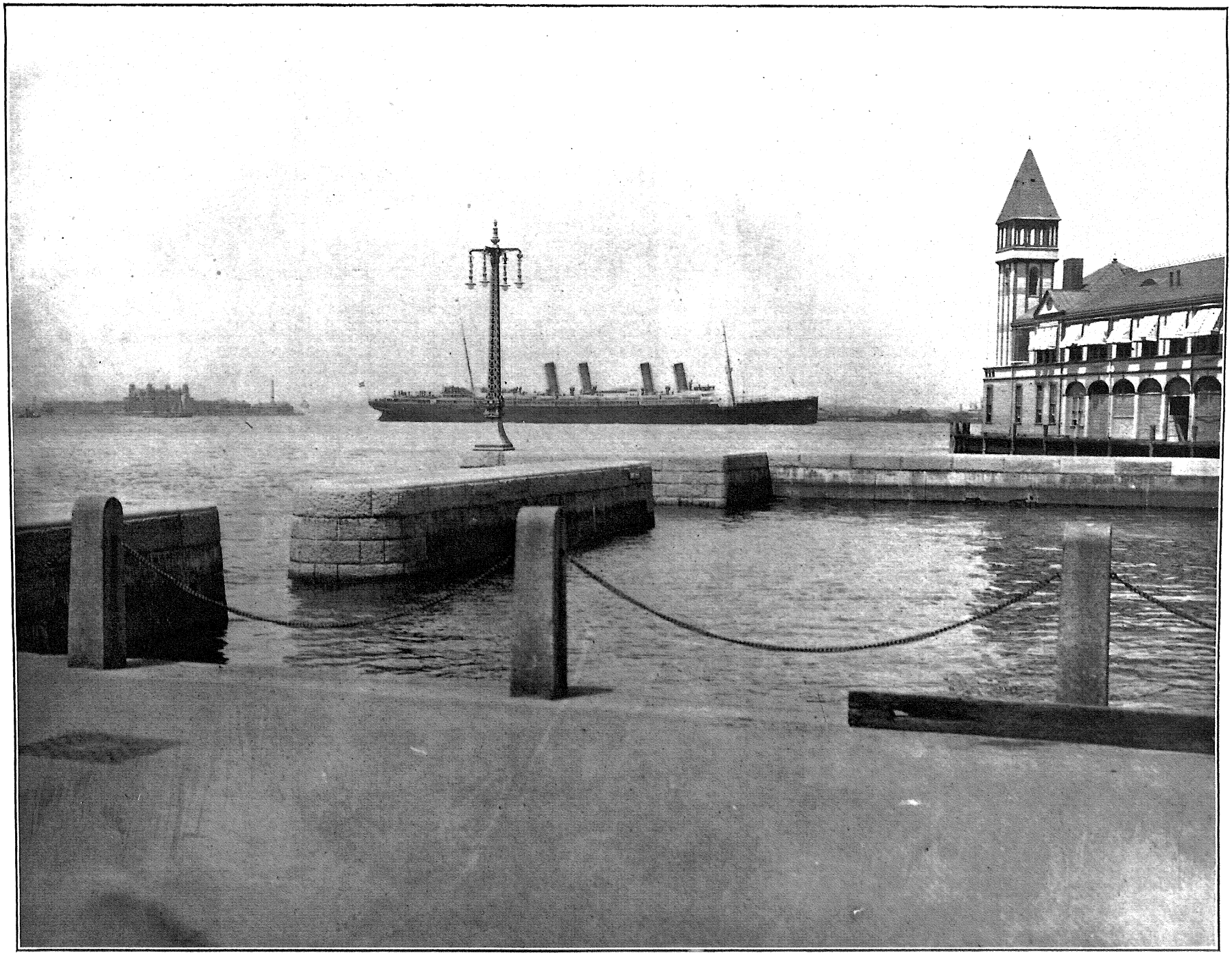
There must always be a certain "line" loss from the resistance of the circuits and from leakage, as well as a further unavoidable loss in such apparatus as transformers, meters, etc. The figures as to this lost and unaccounted for current vary greatly and for different reasons. An interesting discussion of the subject may be found in the proceedings of the twenty-seventh convention of the National Electric Light Association, in 1904. In one instance cited in the discussion, the sale of current supplied over a certain feeder amounted to 83.5 per cent of the output furnished by the station to that feeder, the current lost or unaccounted for being 5.22 per cent, and the total lost and unaccounted for being 16.5 per cent. This would probably be a low figure of loss, and the percentages would run, in many instances, considerably higher.

Cases are on record where the loss of current has been due to actual theft, whether by means of concealed shunting of a part of the current, by tampering with the meters, or by overloading apparatus furnished with current at a flat rate, as, for example, in giving a 5-horsepower motor 10-horsepower work to do. In some of the states special legislation has been invoked to prevent the theft of current.

Reference is made to these points in order that it may not be supposed that the output of stations given herewith can be taken as more than a careful attempt to approximate the output upon which the earnings were predicated or reported; while the difference between the output reported and the current actually found available for sale would in many instances go far to account for high rates associated with a small income.

Irregularity of demand for output.—In many of the stations the apparatus is in full operation during only a small part of the day, on the average, and a great deal of it stands idle for some hours. It is obvious that the output of current on Sundays would fall below the average of other days for large groups of apparatus, such as power motors in factories and incandescent lights in offices. On the other hand, however, the public and many of the commercial arc lighting circuits remain in full operation on Sundays and a large output of current is often called for on special occasions, such as the Christmas holiday week, when many plants are driven so far beyond their capacity that they then reach the highest "peaks" in their load and have to put in operation every piece of available machinery.

Very few, if any, plants are in operation to their full capacity every hour of the day, although at certain hours certain portions of the generating plant are run the full capacity. Thus the arc lighting circuits are fully occupied during certain hours of the night, and some of them all night. The incandescent lighting machines



FIXTURE AT SOUTHERN TIP OF MANHATTAN ISLAND, CONSTITUTING AT ONCE A LAND LIGHT AND A BEACON.

are in use a certain number of hours nightly with varying output, largest in the earlier hours of the evening, and with occasional fluctuations, tapering off toward midnight. The machinery particularly devoted to the production of current for electric motors has the greatest demand upon it during factory hours, and apparatus supplying current for all of these purposes in the larger plants is operated continuously except with occasional intermissions for inspection or possible repairs.

Average output.—The figures given in Tables 75 and 85 may be accepted as a fair approximation to the actual work done by the stations enumerated in this report. According to these tables the average kilowatt hour output of current per day for all stations was 6,960,783, and the total for the year was 2,507,051,115. The stations operated under private ownership reported 2,311,146,676 kilowatt hours, or 92.2 per cent of the output, and those under municipal control 195,904,439 kilowatt hours, or only 7.8 per cent. Translating the kilowatt hours into horsepower hours the average output of current per day was 9,294,456, and the total for the year was 3,341,943,090 horsepower. According to other tables in this bulletin, the total dynamo capacity of central stations was 1,624,980 horsepower or about 1,200,000 kilowatts. As the average kilowatt hour output of current per day is shown to have been 6,960,783, or just short of 7,000,000, it would appear from this that the electric lighting stations in 1902 were on a basis of daily average operation of six hours, or, putting it in another way, approximately 25 per cent of their possible capacity of production of current per day was used.

Average earnings per kilowatt hour.—Since the earnings from the sale of current were $84,186,605 for the year, as shown by Table 1, upon the basis of output quoted above, the 2,507,051,115 kilowatt hours would appear to have earned on an average a little over 3⅓ cents per kilowatt hour. As has been explained, this return per unit can not be taken as exact, but would depend on the varying losses occurring between the generator and switchboard in the central station and the consumers' lamps and motors.

Another way of stating the result from operation and output would be to take the 1,200,000 kilowatt capacity of dynamos and divide it into the earnings from sale of current, which would give an average of $70 per year per kilowatt of capacity; this yielding also an output of almost exactly 2,100 kilowatts per year per kilowatt of capacity. As shown by the tables, however, there were extreme variations from this figure.

Output of private stations, by states and territories.—Table 75 presents, by states and territories, the output of private stations in kilowatt hours and horsepower for the year, and also the average per day. It will be necessary, however, to refer only to the kilowatt hours, as the conversion to the other unit can be readily ascertained by reference to the table. Of the totals reported New York was decidedly at the head of the list, with 695,017,187 kilowatt hours, or not far from one-third of the total for the whole country. To account for the position of New York as a consumer of current upon a vast scale there is not only the enormous consumption area with dense population in and around Manhattan Island, but there are also the gigantic generating plants at Niagara Falls, which accounted for more than 400,000,000 kilowatt hours. Reference to Table 6 shows that New York city alone had an output of 153,288,077 kilowatt hours, or a little over one-fifth of the total for the whole state, and about one-fifteenth of that for the whole country. In the other states the output followed closely the lines of generating capacity and consumption apparatus referred to in the discussion of other tables. The leading states were as follows: Pennsylvania, California, Illinois, Massachusetts, and Ohio. The chief cities in each of these states accounted for very large proportions of this output. Thus in Illinois the output for Chicago was 67,479,260, or over one-half of the total for the state. In California, San Francisco had an output of 55,046,745 kilowatt hours, or slightly less than one-half of the total for the state. In Massachusetts, Boston reported 52,037,255 kilowatt hours, or not far short of one-half of the total for the state. These large proportions were not found in all of the states, although the urban population still remained the largest consumers. In Ohio, for example, Cincinnati reported but one-sixth of the total for the state, but there was nearly as large a consumption also in Cleveland. In Pennsylvania, Philadelphia reported 54,089,356 kilowatt hours, which was about one-quarter of the total, a ratio corresponding with that of New York city to New York state. The consumption of current in most of the Southern states was quite small, but reached large proportions in Missouri, with 49,756,499 kilowatt hours, and Texas, with 46,210,310. Because of the large water-power production already noted the total in South Carolina, not including the stations operated by street railways, ran up to 16,573,550.

Output of municipal stations, by states and territories.—Table 85 gives the output of current in kilowatt hours and horsepower hours for the municipal stations. The total number of kilowatt hours for the year was 195,904,439. The largest output for any state was that for Illinois, where there was a production of 27,660,979 kilowatt hours. Ohio followed closely with 25,900,884. In Michigan the output was 22,889,897, and in Indiana, 18,625,210. The only other states with relatively large production of current were Minnesota, with 11,113,815 kilowatt hours and Pennsylvania, with 11,023,619. The amounts for some of the states were quite trivial, averaging, for example, 254 kilowatt hours per day in both Colorado and Utah. In Rhode Island the output was only 315 kilowatt hours per day; in Idaho, 646; in Oklahoma, 592; and in New Hampshire, 888. Economical production of current under any régime would appear to be simply impossible upon so restricted a basis as this.

CHAPTER VII.

FRANCHISES.

The subject of franchises, with the allied topics of public regulation and public ownership, has been discussed very extensively in the Report on Street and Electric Railways. In most of the states the conditions under which franchises are granted for electric lighting plants are governed by the general laws that apply to street railways and to other public service corporations. Reference may therefore be made with profit to Chapter IX of the special report of the Census Bureau on Street and Electric Railways, since it appears unnecessary to go over the same ground again with corresponding minuteness of detail.

The granting of charters and franchises.—Electric lighting, street railway, and other analogous corporations derive their charters, which give them the right to exist and which regulate in a general way their internal government, from the state through the medium of either a general or a special statute. Usually further definite authorization is necessary before wires may be run along a specific street or highway, and it is this authorization that is designated by the term "franchise" in the more limited sense. By some state constitutions the legislatures are strictly prohibited from granting any use of streets or highways without the consent of the local authorities; and in nearly all the states where this express provision is not found the practice of legislatures is to leave to the local governing body an effective control in this matter. This control ordinarily involves and implies the right of local authorities to impose such conditions as they may see fit at the time the franchise is granted, and these conditions are endless in their variations; sometimes they have been found later to conflict with constitutional requirements, and often it is alleged that they either inflict hardship on the company or make undue concessions to the corporate body in interest, with consequent loss to the community.

It is a truism that virtually the whole of the urban population of the United States lives under the operation of franchises of one kind or another, and that the public welfare is intimately affected by their terms.

Tendency toward combination.—During the later years in the evolution of corporations one of the most pronounced features affecting franchises has been the tendency toward combination, which excludes the assumed benefits of competition and creates under one régime in any city the monopoly or concentrated management of illumination, traction, telephone service, gas supply, and other necessities. The actual effects of combination upon the community continue to be warmly discussed and disputed, and in some instances, in order to avoid dealing with private corporations, the local authorities themselves have undertaken the operation of productive industries as business enterprises.

Municipal ownership.—Discussing this point, Hon. T. M. Cooley says: "The supplying of public conveniences to a city is usually a monopoly, and the protection of the public against excessive charges is to be found first in the municipal power of control. Except in the large cities public policy requires that for supplying light and water there should be one corporation, because one can perform the service at lower rates than two or more, and in the long run will be sure to do so. In some kinds of business competition will keep corporations within bounds in their charges, in others it will not." The broad recognition of this theory or conviction is found in modern franchise practice, which very rarely opposes the carrying into effect of such corporate consolidation, and seeks rather to safeguard the interests of the public by exercising regulation through a board of control. Massachusetts furnishes the best example of such a board, and its regulations will be referred to in detail.

As a matter of fact, all the corporations working under franchises may be said to be more or less strictly accountable to public opinion by resting under the menace of municipal ownership in case the service rendered should be found indifferent and the rates charged should be regarded as exorbitant.

There is a leading opinion by a Massachusetts court in which the majority of justices affirm that the sale of coal and wood is not a public purpose, and that cities and towns could not be authorized by the legislature to open municipal fuel yards.[1] At the same time Massachusetts is the state in which municipal ownership of lighting plants has been most liberally extended, on the broad ground that whatever is of general utility or convenience to any community constitutes a public purpose. The court applies this principle to the manufacture and sale of gas and electric light, on the basis of general convenience of service, the impracticability of each individual rendering the service for himself, and the necessity for using the streets in a special way or of

[1] Opinion of Justices, 155 Mass., 601.

exercising the right of eminent domain. Elsewhere also the furnishing of electric light, heat, and power has been very generally held to be a public purpose, and a proper subject of municipal ownership.

Regulations in various states.—In Ohio the law permits any city or town to buy gas works whenever the council deems it expedient, and this has been treated as including electric light plants. In Iowa a city or town may purchase, establish, or operate electric light and power plants, and also may grant to an individual or corporation the authority to erect or maintain such works for a term not exceeding twenty-five years. No exclusive franchise is to be granted and no plant can be authorized, leased, sold, etc., and no franchise can be changed without a favorable vote of a majority of the electors. Under these provisions it has been held that a municipality may supply its inhabitants with light or water by a plant of its own, even if a franchise for exactly the same purpose has already been granted by the municipality to a private company. In South Carolina, under the constitution of 1895, any city or town, by vote of a majority of its electors, may build or buy waterworks or lighting plants for the supplying of its inhabitants. The same privilege applies in Kansas, under the laws of 1897, and in Missouri. In California municipalities of certain classes, that is, those with a population of 10,000 or less, may purchase, lease, or construct electric light works. The Indiana statutes of 1896 provide "that in cities of a population of 3,500 or more the city authorities may purchase, erect, or operate electric light plants." Under the Maine statutes of 1894 corporations must obtain a franchise for electric lighting plants and make just compensation, and at the end of every franchise period of five years the council may, on a two-thirds vote of the electors, buy, at eminent domain value, and operate electric light, heat, and power plants. In Washington, under the statute of 1897, any incorporated city or town may own and operate electric light plants for the service of both the city and its inhabitants, but a referendum is necessary, and if debt is to be incurred the proposition requires a three-fifths vote at the polls. In Wisconsin any city or village may buy, build, or operate lighting plants for street service.

General statistics.—The general charter and franchise conditions affecting the private electric light and power stations, as embraced in this report, show that 1,573 operated under charter; 300, under special acts of legislature; 2,988, under municipal ordinance; and 173, under other authority. Frequently a station has been granted more than one charter or franchise. The franchise conditions were varied and of wide range. Thus the reports show that exclusive franchises had been granted to 938 of these stations, competitive franchises to 2,398, limited franchises to 1,712, and unlimited franchises to 1,629. These figures should be taken as merely indicating the trend of matters. A number of stations were operated where no authority was ever secured. For example, in a village an individual may have put up poles and strung the wires with the consent of all, or, at least, with no one objecting. Moreover, in some of the largest cities, important systems were being operated without specific franchise conditions. Accordingly, many of the stations filed no answers to the inquiries, while others, it was manifest, answered them incorrectly. Therefore, these figures are not exactly harmonious; yet while they are unsatisfactory they may be taken for what they are worth and as an indication of the general status. In 10 of the states and territories no free service was required, but in no fewer than 35 a cash compensation was required and paid outside of taxes. The amount of cash compensation paid yearly was returned as $199,423, and the amount of free service required was valued at $150,809. These amounts are very small, but the aggregate amount paid in taxes is large, and yet it is probable that all the items for taxes were not included, as there are so many aspects under which a central station may be liable to assessment and taxation. For private stations the taxes reported amounted to $2,654,885 and constituted a large proportion of the $11,456,037 paid out for miscellaneous expenses. For municipal stations the taxes amounted to $10,120. As an example of taxation, it may be cited that the Boston Edison Company was assessed in 1902–3 on a valuation of $9,844,000 and in 1903–4 paid taxes of $163,082 upon a valuation of $10,729,100.

Duration of contract.—Other conditions that would have been of interest are necessarily omitted on account of the insuperable difficulties encountered in securing full information. One of these points, for example, is that of the duration of the contract or franchise. While the franchise may run indefinitely, the contract for street lighting under it may be of brief duration and frequent renewal may be necessary. The best interests of the community are, however, very often served by effecting long contracts, since lower rates can be secured under a long contract than under a contract made for a short period and therefore more uncertain of tenure and renewal. In some cities the contracts have been made in recent years for long periods; for example, in Boston the contract was for ten years, subject to five-year periods of review, and in Baltimore and other cities contracts were for five years. The charter of Greater New York, however, forbids the making of a contract with the franchise corporations for a longer period than one year, and it is contended by the corporations that this is one of the leading reasons why the apparent cost of street lamps is higher in New York than in some other American cities.

Variety of franchises.—Another feature that necessarily escapes consideration is such data as the variety of franchises that may exist in states where the franchises granted prior to the enactment of uniform laws as to franchises were of a heterogeneous character.

Thus in Kentucky 14 of the franchises were reported as being unlimited, whereas the Kentucky constitution of 1891 provides that with regard to electric light and other public service corporations building in any town or city the municipal franchise shall not exceed twenty years. In Iowa the franchise term under the constitution is not to exceed twenty-five years, nor is it to be exclusive; yet 79 stations in that state reported exclusive electric light franchises and 40 reported franchises that were unlimited. In Indiana, according to the statutes of 1896, the franchise periods are not to be of a longer term than twenty-five years; yet 68 franchises in that state were reported as being unlimited.

Charters and franchises in Illinois.—An examination of 128 of the schedules returned for Illinois shows that 48 of the companies reported charters and 2 reported that they had been incorporated under special acts of the legislature. Five were incorporated under the act of 1872. As to franchises, 1 reported a county franchise and all but 3 had municipal franchises; 1 had no authority or right, but had a city contract. One had only a permit to "connect wires to consumers." Exclusive franchises were reported by 11; 21 reported unlimited or perpetual franchises; 99, franchises of ten years and longer; 3, franchises limited to five years; 1, a franchise for one year; and 1, a permit that could be canceled at any time. Twenty-one of the companies reported compulsory free lighting, usually of the city hall, the fire engine houses, the waterworks, and other public buildings. One reported the free lighting of the public library, but this was not compulsory. In Chicago 2 of the stations were required, after five years' operation, to pay the city 4 and 3 per cent, respectively, of the gross revenue. It was reported that one city reserved the use of the poles for fire alarm purposes, but this requirement is undoubtedly much more general, the probability being that many of the stations simply omitted to mention the matter. Most of the ordinances provide for the erection of poles under the supervision of the city, town, or village authorities in charge of streets and of public safety. Nine communities specified a certain kind and character of pole, etc., to be used, and defined the manner of placing the poles and wires, the height of wires and lamps from the ground, the distance of the poles from the curb, etc. These safety provisions, it may also be noted, are subject to the National Electrical Code. Six of the franchises fixed the maximum rate of charge, and two reserved the right to buy the plants operating under the franchises.

The work of the board of gas and electric light commissioners in Massachusetts.—Reference has been made to the conditions existing in the state of Massachusetts, and to the effective work there of the board of gas and electric light commissioners, which has been in existence for some 20 years. This board, while acting as a barrier between private operation and undue competition, has in no wise unduly restricted the action of any community that has desired to establish a plant of its own. It would, indeed, seem to have fostered municipal ownership. Under the legislation enacted and vigilantly enforced by this board, a municipality can undertake the business of electric lighting only upon the passage of certain specific resolutions by the bodies of the electors, etc. After any action upon the proposition, whatever the result of voting, the city or town clerk must forthwith transmit to the board a certified copy of so much of the records of the city or town as relate to the result of the vote. So also, if after authorizing the operation of the plant, it is subsequently voted "to establish, purchase, reconstruct, extend, or enlarge a plant or to issue bonds on account of same, or to regulate the measure or conduct thereof, or to adopt an ordinance or by-law relative to such plant," the city or town clerk must, within ten days after such vote, transmit a certified copy thereof to the board. It is obvious that such requirements insure close supervision.

Municipalities are forbidden to change the price of gas or electricity oftener than once in three months, and when any price is fixed or change is made the management is bound to send a certified copy of the notice of such change to this board. The law requires that "the price shall not, except with the written consent of the board of gas and electric light commissioners, be fixed at less than cost, in which shall be included all operating expenses, interest upon the net investment in the plant, less assessments collected from abutters for extension of pipes or lines at the rate paid upon the bonds, the requirements of the sinking fund established to meet such bonds, and also the depreciation of the plant to be reckoned at not less than 5 per cent per annum of its cost and losses, but any losses exceeding 3 per cent of the investment in the plant may be charged in different years at not more than 3 per cent per annum. Such price shall not be greater than shall allow above such cost a profit of 8 per cent per annum to the city or town upon its net investment. The gas and electricity used by the town shall be charged to it at cost." While the depreciation thus fixed is regarded as low, it is obvious that it acts as a preventive against operating such plants at a serious loss.

An interesting instance of the power of the board in such matters is found in its action in 1902 in the case of Newton, Mass., where it interposed between the municipality and a private company. A certain price for street lighting was insisted upon by the municipality, but it was shown that the rate was too low, and that by insisting upon it the municipality would discriminate against the private customers, who would have to be charged unduly to offset the low rate at which the municipality desired to obtain its street lights. The

board is authorized also to require a city or town to supply a person or corporation aggrieved by its refusal to furnish gas or electricity.

There are various requirements as to careful bookkeeping. "A city or town which manufactures or sells gas or electricity for lighting shall keep record of its work and doings at its manufacturing station, and in respect to its distributing plant as may be required by the board. Books, accounts, and returns shall be made and kept in form prescribed by said board and the accounts shall be closed on the 30th day of June annually, and a balance sheet of that date shall be taken therefrom and included in the return to said board. The mayor and selectmen or municipal light board, if any, shall annually on or before the second Wednesday of September make a return to said board for the year ending on the 30th of June, signed and sworn to by the mayor or a majority of the selectmen or municipal light board, if any, and by the manager, stating the financial condition of said business, the amount of indebtedness, both authorized and existing on account thereof, a statement of income and expenses in such detail as the board may require, and a list of its salaried officers and the salary paid to each. The mayor, selectmen or municipal light board, and manager shall, at any time on request, submit the books and accounts to the inspection of said board and furnish any statement or information required by it relative to the condition, management, and operation of said business."

There is also a provision, which is apparently of very wide scope, as follows: "All general laws relative to the manufacture, use, or distribution of gas or electricity or to the quality thereof, or to the plant or appliances therefor, shall apply to such city or town in the same manner as to persons, so far as applicable and consistent with the provisions of this chapter." The meaning of this passage has never been tested, but would appear to give the board every authority over the affairs of electric lighting business conducted by a municipality just as it is exercised by the board over companies, except where from the nature of the business of a municipal corporation it would be impossible to apply such authority. This authority as exercised in the case of incorporated companies operating under franchise conditions is close and rigid, a full report, as outlined above, being required with regard to all the affairs of the companies and very strict regulations being enforced with regard to the bonded obligations and capital stock of the companies. No new issuance of securities is allowed without a thorough investigation, so as to limit the amount to the value of the new property created and to the necessities of the business. In like manner the board serves as a protector of existing private companies, and does not allow the introduction of new competition unless it is absolutely proven that the company in the field is not living up to its opportunities and that competition would therefore be of benefit to the public.

There is discussion among the private companies in Massachusetts, and a difference of opinion, as to whether the board has served to protect them effectively from competitive "raiding," but the general opinion in the state seems to be that the services of the board have been considerable and of high value, and that without the board the electric lighting and gas industries of Massachusetts would not be upon their present footing of efficiency nor would they be able to give the service to the public that they render. The legislation in Massachusetts relative to the work and power of this board dates back to 1891, and has been amended from time to time; moreover, it has been a model for other states. In discussing the action and results of the law, Prof. E. W. Bemis says: "The extreme restrictions in Massachusetts are due to the intense efforts of the lighting companies. It took a three years' struggle to get the law, and even then it was not possible to pass it except with amendments which seriously diminished its value. The law, however, is much better than none. Before it was passed cities and towns in Massachusetts had no power to establish electric plants even to light their own streets." An interesting and significant result of the creation of this commission is the fact that Massachusetts appears to be the only state in the Union in which full and authentic accounts are kept of the central station industry. This fact alone is a pertinent argument for the value and utility of the board.