DEPARTMENT OF COMMERCE AND LABOR
BUREAU OF THE CENSUS
S. N. D. NORTH, DIRECTOR

SPECIAL REPORTS

TELEPHONES AND TELEGRAPHS

1902

WASHINGTON
GOVERNMENT PRINTING OFFICE
1906

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LETTER OF TRANSMITTAL.

DEPARTMENT OF COMMERCE AND LABOR,
BUREAU OF THE CENSUS,
Washington, D. C., January 23, 1906.

SIR:

I have the honor to transmit herewith a report on the telephone and telegraph systems and the municipal electric fire alarm and police patrol systems of the United States. This report was prepared in accordance with the provisions of section 7 of the act of Congress of March 6, 1902. The statistics cover the calendar year ending December 31, 1902, and were collected and compiled under the supervision of Mr. W. M. Steuart, chief statistician for manufactures. The text has been prepared by Mr. Thomas Commerford Martin, of New York city, expert special agent, with the cooperation and criticism of Mr. A. V. Abbott, as to the telephone portion, and Mr. W. Maver, jr., as to the telegraph portion.

The report presents statistics concerning the physical equipment, service, and financial operations of the commercial and mutual telephone and telegraph systems of the country and the physical equipment of independent rural telephone lines. It also gives data relative to the systems controlled in whole or in part by railway companies, and the ocean cable systems that were in operation all or part of the year.

This is the last of a series of reports on the generation and utilization of electric current. Former reports relate to street and electric railways and central electric light and power plants. The statistics for the telephone and telegraph systems were published on December 15, 1904, as Bulletin 17 of the Bureau of the Census, and those for municipal electric fire alarm and police patrol systems on May 31, 1904, as Bulletin 11.

With the publication of this report the Bureau of the Census closes the first complete census of the generation and utilization of electric current for the transmission of power, messages, and conversation. These industries are of such vast importance, have undergone such rapid changes, and have advanced during the past decade to such an extent that, in order to convey a correct idea of their development, the census should be taken at more frequent intervals than decennially, as required by the present law.

The telephone and telegraph companies have uniformly treated the request of this office for statistical information with the utmost courtesy and consideration. They have freely furnished information of a confidential character concerning their financial operations, and have manifested a willingness to assist in the compilation of reliable statistics, which has been gratifying to all engaged in the work. Some companies have incurred large expense for clerical assistance to compile the data, and have furnished the office with every facility for making a complete report. Unfortunately the account books of some of the smaller companies and mutual systems were so incomplete that accurate answers could not be given to all of the Census inquiries.

Very respectfully,

S. N. D. North,
Director.

HON. VICTOR H. METCALF,
Secretary of Commerce and Labor.

PART I

TELEPHONES

TELEPHONES AND TELEGRAPHS.

By THOMAS COMMERFORD MARTIN, Expert Special Agent.

PART I.

TELEPHONES.

CHAPTER I.

GENERAL STATISTICS.

Introduction.—The first statistics of the telegraph and telephone industries of the United States were those collected for the census of 1880. When the act of Congress of March 3, 1879, made provision for that census, telephony was new and still in the formative stages of development, and telegraphy, after nearly forty years of steady growth, was the great agency for the instantaneous exchange of information. Although the act related specifically to telegraph companies and made no reference to telephony, it was deemed proper and within the scope of the powers of the Census Office to secure such data as was available in regard to the art of telephony. During the period from 1877 to 1880 the telephone industry was to some extent associated with the telegraph companies, just as it has always been in European countries, where in many instances the telegraph systems are governmental institutions. From the standpoint of technique and engineering the relation of telephony and telegraphy is of the most intimate nature, and competent legal decisions in America and abroad have treated them as essentially one art. Telephony has become differentiated from telegraphy, and in the United States it is now conducted as a distinctly separate industry.

By 1899 telephony had become one of the typical American industries, and not only had surpassed telegraphy in physical and financial magnitude, but by its very growth had seriously restricted the expansion of the older art. As a result telegraphy has been regarded by many authorities as being in a condition of arrested development. The introduction of wireless telegraphy is likely, however, to have a marked effect upon the growth of the industry.

The vast strides made by telephony were recognized when the census law of March 3, 1899, was passed, and categorical provision was made for an inquiry regarding telephone systems.

The comparisons made to illustrate the development of the two industries are based upon the statistics shown in the reports of the census of 1880, although the data relative to telephones presented briefly as a part of the statistics of manufactures in 1890 [1] are cited incidentally.

The extraordinary nature of the changes in telephonic evolution is in itself sufficient to debar the statistician or economist from deriving full benefit from the material in hand, or from instituting an analysis that can do justice to the less obvious features of such rapid growth.

Telephony is undergoing even now, about thirty years after the invention of the speaking telephone, a development almost without parallel. It would seem that under such circumstances the data and statistics of most weight would be those derivable from comparisons made for shorter periods than decades, and might well be for five-year terms, as in the census of manufactures.

General statistics for telephone and telegraph systems.—The statistics presented herewith are for the telephone and telegraph business as conducted commercially either for the year ending December 31, 1902, or for the fiscal year most nearly conforming to that year. Table 1, which is a summary for continental United States, indicates the magnitude and the relative importance of the two industries.

[1] Eleventh Census, Bulletin No. 196.

Table 1.—*Comparative summary—telephone and telegraph systems, including submarine cable systems: 1902.*

	Total.	Telephone systems.	Telegraph systems.
Number of systems	4,176	4,151	25
Miles of wire	6,168,836	4,850,486	[1] 1,318,350
Salaried officials, clerks, etc.:			
Number	14,953	14,124	829
Salaries	$11,048,518	$9,885,886	$1,162,632
Wage-earners:			
Average number	91,426	64,628	26,798
Wages	$40,246,776	$26,369,735	$13,877,041
Capital stock and bonds outstanding, par value	$510,977,583	$348,031,058	$162,946,525
Common stock	$385,033,601	$269,180,076	$115,853,525
Preferred stock	$6,069,621	$4,869,621	$1,200,000
Bonds	$119,874,361	$73,981,361	$45,893,000
Total revenue	$127,755,574	$86,825,536	$40,930,038
Operating expenses and fixed charges, except interest on bonds	$90,651,707	$61,652,823	$28,998,884
Interest on bonds	$5,461,098	$3,511,948	$1,949,150
Dividends paid	$21,239,412	$14,982,719	$6,256,693
Net surplus	$10,403,357	$6,678,046	$3,725,311
Total assets	$647,676,321	$452,172,546	$195,503,775
Construction and equipment (including telephones)	$523,473,142	$366,561,694	$156,911,448
Real estate	$27,484,669	$22,716,538	$4,768,131
Stocks and bonds of other companies	$35,878,286	$9,938,342	$25,939,944
Machinery, tools, and supplies	$10,635,486	$9,689,691	$945,795
Bills and accounts receivable	$33,714,416	$30,629,677	$3,084,739
Cash and deposits	$15,579,224	$12,291,840	$3,287,384
Sundries	$911,098	$344,764	$566,334
Total liabilities	$647,676,321	$452,172,546	$195,503,775
Capital stock	$391,103,222	$274,049,697	$117,053,525
Bonds	$119,874,361	$73,981,361	$45,893,000
Cash investment, unincorporated companies	$6,168,609	$6,161,299	$7,310
Bills and accounts payable	$50,547,584	$44,302,999	$6,244,585
Dividends unpaid	$554,733	$188,067	$366,666
Reserves	$38,889,276	$31,029,628	$7,859,648
Sundries	$1,124,265	$1,124,265	....
Surplus	$39,414,271	$21,335,230	$18,079,041

[1] Includes miles of wire operated by Western Union Telegraph Company outside of the United States, but does not include 16,677 nautical miles of cable operated by submarine cable systems.

Table 1 does not include the statistics for the independent farmer or rural telephone lines of a cooperative nature, or those for the telegraph and telephone lines owned by steam and electric railway companies and operated along their tracks for service purposes. For these two classes of lines, together with those used in the electric fire alarm and police patrol systems of the various cities, 358,787 miles of single wire were reported, making, with the 6,168,836 miles shown in Table 1, a total of 6,527,623 miles of single wire used in the transmission of messages, besides the 16,677 nautical miles of cable operated by submarine cable systems owned by American companies. While the total thus obtained contains some duplications, due to the use of the same wire for more than one service, it does not include wire used for purely private purposes, such as connections between two or more places of business or farmhouses, since these lines are not of sufficient importance to be classed as farmer lines. Moreover, it does not include mileage of submarine cables that stretch across the Atlantic and Pacific oceans from American or contiguous shores and are owned and operated by foreign capital, although they may be dependent in very large degree upon American patronage and upon business transferred to them from American land lines.

Dominance of telephony.—Although the commercial telephone has developed entirely during the past thirty years, the comparison made in Table 1 shows that it is of vastly greater importance than the telegraph. In 1902 the telephone systems operated 78.6 per cent of the wire mileage reported for both telephones and telegraphs, gave employment to 70.7 per cent of the wage-earners, paid 65.5 per cent of the wages, received 68 per cent of the total revenue, and paid 67.8 per cent of the total expenses.

In the appendix to this report are printed the special schedules employed in the collection of the telegraph and telephone statistics, and the instructions for their application.

CHAPTER II.

GENERAL TELEPHONE STATISTICS.

Comparative summary.—When the telephone statistics were compiled in 1880, the industry was in an embryonic condition. Human speech was first transmitted over a wire by Prof. Alexander Graham Bell in 1876. A few experimental circuits were established in 1877, and in the same year the industry was given commercial shape. In May, 1877, the first attempt at interconnection on the exchange plan was made in Boston, utilizing burglar alarm circuits, and in January, 1878, the first fully and regularly equipped commercial telephone exchange was opened for business at New Haven, Conn. The early work was done with magneto telephones of limited range as to distance of transmission, but the introduction of the microphone transmitter in 1878 gave a tremendous stimulus to the art, so that by 1880 activity in the exploitation of the business was everywhere manifest. It is a matter of record that in the spring of 1880 the American Bell Telephone Company had in operation some 61,000 transmitting and receiving telephones. The collection of data for the census followed shortly afterwards, yielding results that are compared in Table 2 with those of 1890 and 1902.

TABLE 2.—*Comparative summary—all telephone systems: 1902, 1890, and 1880.*

	1902	1890	1880
Number of systems	4,151	53	148
Miles of wire	4,850,486	240,412	34,305
Number of subscribers	2,178,366	227,357	48,414
Number of stations or telephones of all kinds	2,315,297	233,678	54,319
Number of public exchanges	10,361	1,241	437
Number of employees	78,752	8,645	3,338
Capital stock authorized, par value	$384,534,066	(1)	$17,386,700
Total revenue	$86,825,536	$16,404,583	[2] $3,098,081
Operating expenses and fixed charges	[3] $65,164,771	$11,143,871	[2] $2,373,703
Dividends	$14,982,719	$3,168,208	[2] $302,730
Net surplus	$6,678,046	$2,092,504	[2] $421,648
Total assets	$452,172,546	(1)	[4] $15,702,135
Total investment [5]	$348,031,058	$72,341,736	$14,605,787
Number of messages or talks	5,070,554,553	453,200,000	(1)

[1] Not reported.
[2] Sixteen systems failed to report any financial data.
[3] Including interest on bonds.
[4] Only 74 systems reported assets.
[5] Capital stock and bonds outstanding, par value.

In connection with the statistics presented in Table 2 it may be noted that in 1880 the population of the United States was 50,155,783, and that the number of telephones reported in that year was 54,319; thus there was an average of 923 persons to every telephone. In 1902 the population had increased to an estimated 78,576,436, and the telephones to 2,315,297, the average being about thirty-four persons per telephone. In the 22 years from 1880 to 1902 the total number of public exchanges increased from 437 to 10,361, and the number of employees, from 3,338 to 78,752. The total telephone revenue reported in 1880 was $3,098,081, or an average of $57.03 per telephone, as compared with $86,825,536, or $37.50 per telephone, in 1902. This apparent diminution is explained in small part, however, by the large number of mutual telephones that were in existence in 1902 but were unknown in the earlier period, when all the work was within city limits. The amount of capital stock authorized in 1880 was only $17,386,700, while that for 1902 was $384,534,066, or a little more than twenty-two times greater.

In the presentation of the figures for 1880 in the Census bulletin the industry was referred to as having passed through the stages of an unprecedented development during the census year of 1879–80. At the beginning of that year the industry amounted to little or nothing, but at the end of the year it represented one of the great interests of the country. In addition to the 148 systems that made reports in 1880 there were some companies and individuals known to own telephone machinery and wire from whom no reports could be obtained, because when the Tenth Census was taken they either had not fully organized or had not commenced operations. Hence the statistics for 1880 should be regarded only as a fair approximation to the telephone exchange industry at that time.

The bulletin of 1890 called attention to the fact that the number of subscribers had increased 369.6 per cent during the decade, the number of subscribers per exchange had increased 64.9 per cent, and the mileage of wire per subscriber had increased 49.3 per cent. The comment was made that these increases showed how necessary the telephone service had become in commercial and social affairs, and spoke volumes for the enterprise that had attended the development of inventive genius in this branch of the electrical industries.

Summary of systems in outlying districts.—Reports were received for 1 system in Alaska, 1 in the Philippines, and 7 in Hawaii, these systems reporting in the aggregate 5,518 miles of single wire and 2,891 telephones. The statistics are summarized in Table 3.

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TABLE 3.—*Summary—outlying districts: 1902.*

Number of systems	9
Miles of wire	5,518
Number of subscribers	2,880
Number of stations or telephones of all kinds	2,891
Number of public exchanges	14
Number of pay stations	8
Number of party lines	796
Number of stations on party lines	1,595
Manual switchboards, total number	14
Common battery	2
Magneto	12
Messages or talks during year, total number	3,887,925
Salaried officials, clerks, etc.:	
Number	28
Salaries	$25,908
Wage-earners:	
Average number	134
Wages	$43,532
Capitalization:	
Authorized, common stock	$507,900
Outstanding, common stock	$390,745
Total revenue	$135,568
Operating expenses and fixed charges	$90,469
Dividends paid	$25,858
Net surplus	$19,241
Total assets	$531,197
Construction and equipment	$409,676
Telephones	$61,785
Real estate	$31,782
Machinery, tools, and supplies	$6,869
Bills and accounts receivable	$16,966
Cash and deposits	$4,119
Total liabilities	$531,197
Capital stock	$390,745
Reserves	$8,758
Bills and accounts payable	$22,995
Dividends unpaid	$771
Net surplus	$107,928

No reports were received for the telephone lines in Porto Rico, and, except in Table 3, the data for the telephone systems in the outlying districts of the United States are excluded from the statistics presented in this report.

Classification of systems.—In compiling the present statistics each system—comprising all the telephone lines, exchanges, and toll stations owned and operated by any individual, collection of individuals, firm, or corporation—was considered as a unit requiring a separate report. Companies organized to finance operating companies or to control them by the ownership of the majority of the stock, but not engaged in actual operation of exchanges, were not reported. Companies simply manufacturing apparatus were, of course, excluded.

There are many individual telephone plants of a purely private character operating in one building or connecting two or more buildings or places of business. These correspond to isolated plants in electric lighting, and no attempt was made to enumerate lines or systems of this character, although the numerous private branch exchanges operated as part of telephone exchanges for the more efficient service of the subscriber are duly brought to account in the exchange statistics.

The American Telephone and Telegraph Company and its 43 licensee corporations were counted as 44 separate systems. The reports for the 43 licensee companies were credited to the states in which their operating headquarters were located, and the long distance system operated by the American Telephone and Telegraph Company was credited to New York, its operating or official headquarters being located in New York city. In cases where the same company operated exchanges in more than one state the combined reports for all its exchanges were counted as for one system, but separate reports were obtained for the equipment and business of the individual exchanges in each state, so as to give proper credit to the respective states.

The statistics are shown separately in this report for three distinct classes of telephone systems as follows:

1. Commercial systems, including all systems operated by individuals, firms, or corporations, primarily for revenue.

2. Mutual systems, including all systems operated through a mutual arrangement among persons deriving benefit from the service, primarily for the benefit of the owners, revenue being incidental to the operation of the line.

3. Independent farmer or rural lines, including all lines having no regular exchange or central office. These lines are often operated under conditions similar to those controlling mutual systems.

The rural telephone lines usually consist of one or more circuits strung through a sparsely settled rural district and connected to the various farmhouses. Frequently these lines operate on a grounded circuit, barbed wire fences being sometimes utilized. Often these systems connect in some manner with a mutual system or with a commercial system, and in this way obtain for their owners the advantage of extended telephonic connection.

Obviously the natural course of evolution in telephonic systems is the formation of a mutual system by the consolidation of two or more rural lines, which unite and establish an exchange for the benefit of the several owners; and next, the mutual system as it grows and extends is likely to become incorporated and be transformed into a commercial system.

Only the commercial systems were known to the earlier art and to the censuses of 1880 and 1890, and until the expiration of the fundamental Bell telephone patents the industry had remained virtually under the control of one corporation with one centralized management. During the present decade, however, a great many independent and mutual companies have been established, and in some states such systems are of great importance, although in 1902 there was no mutual system in any large center of population. Great activity prevailed during the census year in the formation of new local telephone exchange companies and in the consolidation of existing independent companies. As a result of this development the collection of the latest statistics was a task of considerable difficulty and magnitude. Although it is probable that in some respects the data are incomplete, the totals may be accepted as an accurate indication of the condition of the industry during 1902.

Statistics for systems, by class.—Table 4 shows, for each of the three classes, the number of systems, miles of single wire, and number of telephones (not including any instruments employed by the systems exclusively for their own use) in continental United States in 1902. These items constitute the only information obtainable for the independent rural lines, hence the statistics for these lines are omitted from all tables unless otherwise stated.

TABLE 4.—*Number of systems and independent rural lines, miles of wire, and number of telephones: 1902.*

	Total.	Commercial.	Mutual.	Independent rural lines.
Number of systems and lines	9,136	3,157	994	4,985
Miles of wire	4,900,451	4,779,571	70,915	49,965
Number of telephones	2,371,044	2,225,981	89,316	55,747

At the end of 1902 there were in operation in continental United States 9,136 telephone systems and independent farmer or rural lines, with 4,900,451 miles of single wire and 2,371,044 telephones.

There were 4,985 independent lines reported, or 54.6 per cent of all the systems and lines. These lines have had a remarkable development during the past six years. In Illinois, Indiana, Iowa, and Missouri there were 3,758 lines of this character, or 75.4 per cent of the total number.

Of the total wire mileage the commercial telephone systems operated 97.5 per cent, the mutual systems 1.5 per cent, and the independent farmer or rural lines 1 per cent. Of the telephones the commercial systems reported 93.9 per cent, the mutual systems 3.8 per cent, and the independent farmer or rural lines 2.3 per cent.

The average numbers of telephones per system were 705 for the commercial systems, 90 for the mutual, and 11 for the rural. But such averages lose sight of the fact that the bulk of the business is transacted by a comparatively small number of the systems. The reports show that out of the 4,151 commercial and mutual systems only 194, or 4.7 per cent, operated 1,000 or more telephones, but these 194 systems returned 1,679,199 telephones, or 72.5 per cent, of all the instruments in use. This is evidence of the existence in telephony of the prevalent tendency toward consolidation.

Though the independent rural lines must be included in a complete enumeration of the telephone facilities of the United States, they must be excluded from the category of commercial undertakings. When they are excluded, the telephone systems are divided into commercial and mutual and appear as in Table 5.

TABLE 5.—*Summary—all systems: 1902.*

	Total.	Commercial.	Mutual.
Number of systems	4,151	3,157	994
Miles of wire	4,850,486	4,779,571	70,915
Number of subscribers	2,178,366	2,089,846	88,520
Number of stations or telephones of all kinds	2,315,297	2,225,981	89,316
Number of public exchanges	10,361	9,419	942
Number of private branch exchanges	7,883	7,883	....
Number of automatic pay stations	32,477	32,459	18
Number of all other pay stations	48,393	48,009	384
Number of party lines	258,166	248,908	9,258
Number of stations on party lines	886,152	808,571	77,581
Switchboards, total number	10,896	9,954	942
Manual:			
Common battery	837	830	7
Magneto	10,005	9,071	934
Automatic	54	53	1
Messages or talks during year, total number	5,070,554,553	4,971,413,070	99,141,483
Local exchange	4,949,849,709	4,851,416,539	98,433,170
Long distance and toll	120,704,844	119,996,531	708,313
Salaried officials, clerks, etc.:			
Number	14,124	13,958	166
Salaries	$9,885,886	$9,871,596	$14,290
Wage-earners:			
Average number	64,628	63,630	998
Wages	$26,369,735	$26,206,065	$163,670
Capital stock and bonds outstanding, par value	$348,031,058	$347,366,793	$664,265
Common stock	$269,180,076	$268,518,811	$661,265
Preferred stock	$4,869,621	$4,869,621	....
Bonds	$73,981,361	$73,978,361	$3,000
Total revenue	$86,825,536	$86,522,211	[1] $303,325
Operating expenses and fixed charges, except interest on bonds	$61,652,823	$61,371,002	$281,821
Interest on bonds	$3,511,948	$3,511,768	$180
Dividends paid	$14,982,719	$14,981,649	$1,070
Net surplus	$6,678,046	$6,657,792	$20,254

[1] Includes assessments.

Table 5 shows 4,151 systems, of which the commercial lines comprised 3,157, or 76.1 per cent, and the mutual lines 994, or 23.9 per cent. The commercial telephone companies controlled 98.5 per cent of the wire mileage and 96.1 per cent of the telephones in use, and reported 95.9 per cent of all the subscribers. The proportion of the telephone business transacted by the systems operated cooperatively for convenience rather than profit was very small.

It is interesting to contrast the relative proportions of the telephone systems operated by the American Telephone and Telegraph Company and those under the independent organizations, as shown in Table 6.

TABLE 6.—*Summary—Bell and independent systems: 1902.*

	Total.	Bell.	Independent.
Number of systems	4,151	44	4,107
Miles of wire	4,850,486	3,387,924	1,462,562
Number of subscribers	2,178,366	1,222,327	956,039
Number of stations or telephones of all kinds	2,315,297	1,317,178	998,119
Number of public exchanges	10,361	3,753	6,608
Number of private branch exchanges	7,883	7,266	617
Number of automatic pay stations	32,477	26,573	5,904
Number of other pay stations	48,393	29,083	19,310
Switchboards, total number	10,896	3,820	7,076
Manual:			
Common battery	837	356	481
Magneto	10,005	3,463	6,542
Automatic	54	1	53
Messages or talks during year, total number	5,070,554,553	3,074,530,060	1,996,024,493
Local exchange	4,949,849,709	2,998,344,933	1,951,504,776
Long distance and toll	120,704,844	76,185,127	44,519,717
Salaried officials, clerks, etc.:			
Number	14,124	10,341	3,783
Salaries	$9,885,886	$7,848,551	$2,037,335
Wage-earners:			
Average number	64,628	46,064	18,564
Wages	$26,369,735	$21,026,257	$5,343,478

It appears that out of a total of 4,151 systems the American Telephone and Telegraph Company operated 44, or 1.1 per cent, and the independent companies, 4,107, or 98.9 per cent. In other words, there were about ninety-three times more organized systems among the independent interests than among the Bell companies, but the latter, in which consolidation had already gone so much further, had 131.6 per cent more miles of wire, 27.9 per cent more subscribers, and 32 per cent more telephones, and handled 54 per cent more messages.

The reports show that there were independent exchanges in all the states and territories except the District of Columbia and Utah. The American Telephone and Telegraph Company operated in all regions except Indian Territory, and predominated in 20 states and territories. In these states and territories there were 2,615 exchanges, of which the Bell interests controlled 1,992, or 76.2 per cent.

Statistics by geographic divisions.—Table 7 shows the relation between population, telephones, and messages, and Table 8 summarizes, by geographic divisions, the principal items for all classes of telephone systems.

Table 7.—ALL SYSTEMS—TELEPHONES, MESSAGES, AND POPULATION, WITH PERCENTAGES AND AVERAGES, BY GEOGRAPHIC DIVISIONS: 1902.

DIVISION.	Estimated population.	Number of stations or telephones of all kinds.	Number of messages or talks during year.	PERCENTAGE OF TOTAL.			AVERAGE.		
				Population.	Telephones.	Messages or talks.	Population per telephone.	Number of messages per capita.	Number of messages per telephone.
United States	78,576,436	2,315,297	5,070,554,553	100.0	100.0	100.0	34	65	2,190
North Atlantic	21,778,196	647,670	1,208,179,198	27.7	28.0	23.8	34	55	1,865
South Atlantic	10,770,414	143,314	353,559,870	13.7	6.2	7.0	75	33	2,467
North Central	27,087,206	1,091,168	2,446,257,875	34.5	47.1	48.3	25	90	2,242
South Central	14,651,535	225,999	681,497,626	18.6	9.8	13.4	65	47	3,015
Western	4,289,085	207,146	381,059,984	5.5	8.9	7.5	21	89	1,840

Table 8.—ALL SYSTEMS—SUMMARY BY GEOGRAPHIC DIVISIONS: 1902.

DIVISION.	Number of systems.	Miles of wire.	Number of stations or telephones of all kinds.	Number of public exchanges.	Number of switchboards of all kinds.	Number of messages or talks during year.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		Total revenue.	Total expenses.	Net surplus
							Number.	Salaries.	Average number.	Wages.			
United States	4,151	4,850,486	2,315,297	10,361	10,896	5,070,554,553	14,124	$9,885,886	64,628	$26,369,735	$86,825,536	$80,147,490	$6,678,046
North Atlantic	490	1,669,248	647,670	2,330	2,480	1,208,179,198	5,703	4,779,345	21,702	10,204,325	36,741,249	35,773,374	967,875
South Atlantic	421	322,376	143,314	791	830	353,559,870	1,015	645,107	4,025	1,453,419	4,530,560	4,132,206	398,354
North Central	2,568	2,015,087	1,091,168	5,212	5,500	2,446,257,875	4,768	2,961,686	25,445	8,986,075	29,682,263	26,078,185	3,604,078
South Central	565	538,347	225,999	1,144	1,199	681,497,626	1,266	841,390	7,060	2,419,070	7,941,911	6,700,757	1,241,154
Western	107	305,428	207,146	884	887	381,059,984	1,372	658,358	6,396	3,306,846	7,929,553	7,462,968	466,585

The North Central division returns show 61.9 per cent of the total number of systems and 41.5 per cent of the total wire mileage. Moreover, as this division had the largest population—34.5 per cent of the total—it naturally transacted the greatest amount of business as measured by the number of messages, showing 48.3 per cent.

Table 9 summarizes the statistics for the commercial systems.

Table 9.—COMMERCIAL SYSTEMS—SUMMARY BY GEOGRAPHIC DIVISIONS: 1902.

DIVISION.	Number of systems.	Miles of wire.	Number of stations or telephones of all kinds.	Number of public exchanges.	Number of switchboards of all kinds.	Number of messages or talks during year.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		Total revenue.	Total expenses.	Net surplus.
							Number.	Salaries.	Average number.	Wages.			
United States	3,157	4,779,571	2,225,981	9,419	9,954	4,971,413,070	13,958	$9,871,596	63,630	$26,206,065	$86,522,211	$79,864,419	$6,657,792
North Atlantic	371	1,666,263	643,014	2,256	2,406	1,203,979,018	5,693	4,778,888	21,643	10,197,916	36,723,783	35,757,126	966,657
South Atlantic	348	317,827	139,319	729	768	349,373,521	1,012	644,946	3,977	1,449,047	4,515,004	4,117,265	397,739
North Central	1,856	1,957,250	1,014,164	4,442	4,730	2,361,506,911	4,626	2,950,741	24,605	8,842,764	29,437,516	25,851,055	3,586,461
South Central	496	534,648	223,507	1,121	1,176	677,517,694	1,261	839,505	7,029	2,414,545	7,927,428	6,686,816	1,240,612
Western	86	303,583	205,977	871	874	379,035,926	1,366	657,516	6,376	3,301,793	7,918,480	7,452,157	466,323

The North Central division returned 1,856, or 58.8 per cent, of the commercial systems, and 1,014,164, or 45.6 per cent, of the commercial telephones.

The commercial systems controlled the larger proportion of the wire and telephones operated by the independent systems, and their development is the important factor in the growth of the independent movement. Table 10, showing the distribution of the existing independent commercial systems according to the year in which established, by states and territories, indicates the rapidity of the growth of this feature of telephony.

TABLE 10.—DISTRIBUTION OF EXISTING INDEPENDENT COMMERCIAL SYSTEMS ACCORDING TO YEAR IN WHICH ESTABLISHED, BY STATES AND TERRITORIES: 1883 TO 1902.

STATE OR TERRITORY.	Total.	1902	1901	1900	1899	1898	1897	1896	1895	1894	1893	1892	1891	1890	1889	1888	1887	1886	1885	1884	1883
United States	3,113	528	549	508	380	334	254	207	199	80	18	12	8	7	6	8	3	5	4	2	1
Alabama	43	10	10	6	2	3	2	4	5	1											
Arizona	10	2	3	1		3			1												
Arkansas	76	7	15	16	8	8	4	7	2	4	2				1	1	1				
California	10	1	1	1	1			1	1		1	2		1							
Colorado	8	3	2	2				1													
Connecticut	4				1	1	1			1											
Delaware	3		1			1			1												
Florida	23	2	3	4	2	5	2	2	1			1		1							
Georgia	71	10	8	11	10	12	8	9	3												
Idaho	5	1		1	1	1								1							
Illinois	240	27	42	39	31	29	30	13	20	5	2	1								1	
Indian Territory	37	10	11	3	4	6	1	2													
Indiana	261	37	47	48	31	19	29	19	20	9		1			1						
Iowa	240	60	50	41	31	16	10	12	10	6	2		1		1						
Kansas	161	37	33	31	23	13	9	3	10	2											
Kentucky	84	14	14	15	9	9	3	9	7	1	2			1							
Louisiana	14	2	1	2	3	1	2	3													
Maine	21	4	3	3	2	1	2	1	2						2			1			
Maryland	15		3		1	3	2	2	1	3											
Massachusetts	8		1	1	1	1	1	2		1											
Michigan	76	10	8	12	10	10	6	8	6	4	1										1
Minnesota	118	26	17	18	17	22	6	3	7		1		1								
Mississippi	32	6	7	2	1	3	6	4	1	1							1				
Missouri	225	29	45	24	25	26	23	28	14	7		1	1	1		1					
Montana	4			1	1	1					1										
Nebraska	73	26	17	5	12	6	3		3	1											
Nevada	6	2	1		1		1					1									
New Hampshire	14	1		3	3	1	2	2	1	1											
New Jersey	28	5	3	1	4	3	4	3	3	2											
New Mexico	12	1	2	4	1			1	2	1											
New York	171	38	29	25	18	15	15	8	13	8			1			1					
North Carolina	71	11	8	11	6	14	6	5	8	1								1			
North Dakota	29	9	8	1	2	4	1	2	1				1								
Ohio	234	30	40	51	39	21	18	10	17	4	2			1					1		
Oklahoma	23	4	9	3	4	2		1													
Oregon	16	2	5	2			1	1	3	1	1										
Pennsylvania	73	8	6	16	5	13	8	9	5	3											
Rhode Island	1	1																			
South Carolina	36	5	4	8	5	2	2	4	3	1	1								1		
South Dakota	47	11	9	8	6	5	3	2	1	1								1			
Tennessee	28	3	3	9	2		7	1		2						1					
Texas	156	27	34	26	20	19	8	8	7	2	1			1	1		1	1			
Utah	4			1			1	1	1												
Vermont	30		3	6	9	4	2	1	3	1										1	
Virginia	65	16	9	7	7	7	8	2	2	3		1				2		1			
Washington	5	1	2	1					1												
West Virginia	62	7	7	10	5	10	7	4	4		1	3	3						1		
Wisconsin	139	21	25	28	16	14	10	9	9	3		1				2			1		
Wyoming	1	1																			

While Table 10 is based upon the replies received in answer to the direct inquiry, "Date when this exchange system was first established," it is possible that in some instances the date of the reorganization of the system was given, instead of that of its original establishment. In sections where reorganization has been very active during recent years such a mistake would be apt to occur.

Table 10 shows that of the independent commercial systems still in existence, the first was established in 1883, and that between 1883 and 1893, inclusive, 74 such systems were organized. Inasmuch, however, as the Bell patents did not expire until 1893 it might seem a misnomer to call these 74 systems independent, as it is perhaps hardly possible that they all operated independently of the American Bell Telephone Company. During the early life of the Bell patents a number of exchanges were organized under the Edison and Elisha Gray patents and were operated in opposition to the Bell system, but the rapid increase in the number of independent commercial systems dates naturally from 1893, when the Bell patents expired; during the nine years from 1894 to 1902, inclusive, there were 3,039 such systems established.

Table 11 summarizes the statistics for the mutual systems.

Table 11.—MUTUAL SYSTEMS—SUMMARY BY GEOGRAPHIC DIVISIONS: 1902.

DIVISION.	Number of systems.	Miles of wire.	Number of stations or telephones of all kinds.	Number of public exchanges.	Number of switchboards of all kinds.	Number of messages or talks during year.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		Total revenue.	Total expenses.	Net surplus.
							Number.	Salaries.	Average number.	Wages.			
United States	994	70,915	89,316	942	942	99,141,483	166	$14,290	998	$163,670	$303,325	$283,071	$20,254
North Atlantic	119	2,985	4,656	74	74	4,200,180	10	457	59	6,409	17,466	16,248	1,218
South Atlantic	73	4,549	3,995	62	62	4,186,349	3	161	48	4,372	15,556	14,941	615
North Central	712	57,837	77,004	770	770	84,750,964	142	10,945	840	143,311	244,747	227,130	17,617
South Central	69	3,699	2,492	23	23	3,979,932	5	1,885	31	4,525	14,483	13,941	542
Western	21	1,845	1,169	13	13	2,024,058	6	842	20	5,053	11,073	10,811	262

According to Table 11, there were 994 mutual systems, of which 712, or 71.6 per cent, were in the North Central division, while only 21, or 2.1 per cent, were in the Western states. The North Atlantic division ranked second in the number of mutual systems, notwithstanding the fact that 4 of the 9 states in this division did not report any. In the North Central division there were 77,004 telephones, or 86.2 per cent of the total number, returned by the mutual systems.

Table 12 shows the number of existing mutual systems established during each year in each state and territory.

Table 12.—DISTRIBUTION OF EXISTING MUTUAL SYSTEMS ACCORDING TO YEAR IN WHICH ESTABLISHED, BY STATES AND TERRITORIES: 1881 TO 1902.

STATE OR TERRITORY.	Total.	1902	1901	1900	1899	1898	1897	1896	1895	1894	1893	1891	1888	1883	1881
United States	994	295	269	181	84	75	32	21	15	7	9	2	1	1	2
Alabama	4	2		2											
Arizona	1					1									
Arkansas															
California	6	1		1		1	1	1			1				
Colorado	3	1			1				1						
Connecticut	1				1										
Delaware															
District of Columbia															
Florida	2		1				1								
Georgia	6	3	2	1											
Idaho	1	1													
Illinois	138	36	33	34	13	14	3	4			1				
Indian Territory															
Indiana	105	37	41	17	4	3	2			1					
Iowa	170	83	58	18	6	2		1			1				1
Kansas	11	5	2	3	1										
Kentucky	35	3	8	9	4	5	1	2	2	1					
Louisiana	1				1										
Maine	4	2	1	1											
Maryland	4		2		1				1						
Massachusetts															
Michigan	33	13	8	3	4		1		2	1	1				
Minnesota	31	12	9	3	4	3									
Mississippi	3				1			1	1						
Missouri	90	21	26	13	8	6	9	4	1		2				
Montana	2	2													
Nebraska	32	12	13	4	1	2									
Nevada	2		1		1										
New Hampshire															
New Jersey															
New Mexico															
New York	88	7	19	24	10	13	2	3	2	2	2	2		1	1
North Carolina	12	1	5	2	1	3									
North Dakota	3	1	1	1											
Ohio	49	13	13	16	2	4	1								
Oklahoma	1	1													
Oregon	5	3	1	1											
Pennsylvania	20	2	6	6	2	1	2		1						
Rhode Island															
South Carolina	6	2	1	2		1									
South Dakota	7	7													
Tennessee	13		3	1	2	2	2	1	2						
Texas	12	2	2	3	2	3									
Utah															
Vermont	6			1	1	1	1	1		1					
Virginia	22	3	2	6	4	2	2	1		1			1		
Washington															
West Virginia	21	6	3	2	4	3		2			1				
Wisconsin	43	13	8	6	5	5	4		2						
Wyoming	1			1											

The date of the establishment of the systems was given in reply to a direct question, but it is liable to the uncertainties referred to in connection with the commercial systems.

Accepting the numbers reported for each year as indicating the growth of mutual systems, it appears that between 1881 and 1895, inclusive, there were 37 such systems established, and from 1896 to 1899, inclusive, 212 systems. In 1900 there was a large increase in the mutual ownership, 181 systems being established. But the great increase began with the present century, 269 mutual systems being established in 1901 and 295 in 1902. In 1902 Iowa—probably one of the first states in which a mutual system was established—had 170 systems, or 17.1 per cent of the total number of these systems; 159, or 93.5 per cent, were established between 1900 and 1902, inclusive. There were no mutual systems reported as in operation during the year covered by this report in Arkansas, Delaware, the District of Columbia, Indian Territory, Massachusetts, New Hampshire, New Jersey, New Mexico, Rhode Island, Utah, or Washington.

Rural lines.—Table 13 shows approximately the number of rural lines, classified as commercial, mutual, and independent so far as it has been possible to segregate them, and gives the mileage of wire and the number of telephones for each class by geographic divisions. These statistics, except those relating to the independent rural lines, are included in the tables immediately preceding. The subject is more fully considered under "Rural substations" in Chapter VI.

TABLE 13.—NUMBER OF RURAL LINES, CLASSIFIED AS COMMERCIAL, MUTUAL, AND INDEPENDENT RURAL, WITH THE WIRE MILEAGE AND THE NUMBER OF TELEPHONES, BY GEOGRAPHIC DIVISIONS: 1902.

DIVISION.	NUMBER OF LINES.				MILES OF WIRE.				NUMBER OF TELEPHONES.			
	Total.	Commercial.	Mutual.[1]	Independent rural.	Total.	Commercial.	Mutual.	Independent rural.	Total.	Commercial.	Mutual.	Independent rural.
United States	21,577	15,598	994	4,985	259,306	138,426	70,915	49,965	266,968	121,905	89,316	55,747
North Atlantic	1,151	947	119	85	18,069	14,152	2,985	932	18,706	12,499	4,656	1,551
South Atlantic	1,195	674	73	448	17,824	7,629	4,549	5,646	11,268	3,822	3,995	3,451
North Central	18,069	13,186	712	4,171	205,660	108,475	57,837	39,348	226,606	100,856	77,004	48,746
South Central	958	634	69	255	13,889	6,564	3,699	3,626	7,829	3,546	2,492	1,791
Western	204	157	21	26	3,864	1,606	1,845	413	2,559	1,182	1,169	208

[1] Systems.

The total number of rural lines in operation in the United States in 1902 was 21,577. Of this number, 15,598, or 72.3 per cent, were owned by commercial systems; 994, or 4.6 per cent, were controlled by the mutual systems; and the remaining 4,985, or 23.1 per cent, were independent farmer or rural lines.

More than three-fourths of these lines were in the North Central division, the proportion being 83.7 per cent, and the number, 18,069. This division also contained the greatest number in each class of rural lines, the proportions being as follows: Commercial, 84.5 per cent; independent, 83.7 per cent; and mutual, 71.6 per cent. Of the total rural lines in the North Central division, the proportions formed by the various classes were 73 per cent for commercial, 23.1 per cent for independent, and 3.9 per cent for mutual lines.

The South Atlantic division ranked second in the number of lines, although its proportion of the total rural lines was only 5.5 per cent. The North Atlantic states ranked third, with 5.3 per cent.

Only Delaware, the District of Columbia, New Jersey, and Utah did not report any line of a purely rural character. No mutual rural systems were reported for Arkansas, Indian Territory, Massachusetts, New Hampshire, New Mexico, Rhode Island, or Washington, and no independent rural lines were found in Colorado, Connecticut, Maryland, Massachusetts, Nevada, New Hampshire, North Dakota, Oklahoma, Rhode Island, or Washington. It is probable that some small systems of this character were in operation in these states and territories, but it was impossible to locate them or obtain any information concerning them.

CHAPTER III.

TELEPHONE CAPITALIZATION.

Capitalization of incorporated companies.—The capitalization of incorporated telephone companies is exhibited in Table 14, which shows the amount of capital stock, preferred and common, authorized and outstanding; the amount of dividends paid on each kind of stock; the amount of authorized and outstanding funded debt; and the amount of interest paid thereon during the census year.

TABLE 14.—*Capitalization of incorporated companies—all systems: 1902.*

	Total.	Commercial.	Mutual.
Number of incorporated companies	2,271	1,924	347
Capital stock and bonds authorized, par value	$542,633,160	$541,080,781	$1,552,379
Capital stock and bonds outstanding, par value	$348,031,058	$347,366,793	$664,265
Capital stock:			
Total authorized, par value	$384,534,066	$382,988,687	$1,545,379
Total outstanding, par value	$274,049,697	$273,388,432	$661,265
Dividends paid	$14,982,719	$14,981,649	$1,070
Common—			
Authorized, par value	$373,852,341	$372,306,962	$1,545,379
Outstanding, par value	$269,180,076	$268,518,811	$661,265
Dividends paid	$14,895,857	$14,894,787	$1,070
Preferred—			
Authorized, par value	$10,681,725	$10,681,725	....
Outstanding, par value	$4,869,621	$4,869,621	....
Dividends paid	$86,862	$86,862	....
Bonds:			
Authorized, par value	$158,099,094	$158,092,094	$7,000
Outstanding, par value	$73,981,361	$73,978,361	$3,000
Interest paid	$3,511,948	$3,511,768	$180
Assessments levied	$137,536	....	$137,536

Of the 4,151 telephone systems included in the report, 2,271, or 54.7 per cent, divided into the two classes—commercial and mutual—were operated by incorporated companies. The commercial group was largely predominant, as 1,924, or 84.7 per cent, of the incorporated companies operated commercial systems and only 347, or 15.3 per cent, operated mutual systems.

As a number of companies operated in more than one state, and the capitalization of such companies covered their entire equipment, it was impossible to segregate either the stock or bonds so as to present the figures by states and territories; hence only the totals for the United States are shown.

Of the total authorized capitalization, the par value of capital stock constituted 70.9 per cent, and that of bonds or funded debt, 29.1 per cent. At the end of the year covered by the reports 64.1 per cent of the authorized capital had been issued and was outstanding. Of the total par value of capital stock outstanding, common stock represented 98.2 per cent and preferred stock, 1.8 per cent. Of the $14,982,719 reported as paid in dividends, $14,895,857, or 99.4 per cent, was paid on common stock. The par value of all common stock outstanding amounted to $269,180,076, and the dividends indicated an average rate of 5.5 per cent. There were, however, 1,627 companies with outstanding common stock of a par value of $46,933,950 that paid no dividend, the dividends being paid by companies with common stock having a par value of $222,246,126; therefore the average rate of dividends was 6.7 per cent. The dividends paid on preferred stock amounted to $86,862, an average of 1.8 per cent on all such stock; but there were 17 companies with outstanding preferred stock of a par value of $461,025 that paid no dividend. The par value of the preferred stock of the companies paying dividends on such stock was $4,408,596, or an average rate of 2 per cent. The majority of the companies charged interest on funded debt outstanding as having been paid. The total amount of interest was $3,511,948, an average rate of 4.7 per cent.

The $137,536 shown as received in assessments was reported by the mutual companies as the amount levied during the year in order to meet current expenses and make necessary improvements and extensions.

Capitalization of commercial systems.—The incorporated commercial telephone systems numbered 1,924, or 60.9 per cent of the total of 3,157 commercial systems.

Of the total capital outstanding, $273,388,432, or 78.7 per cent, was in stock, and $73,978,361, or 21.3 per cent, was in bonds. The par value of the preferred stock was $4,869,621, or 1.8 per cent of the par value of all the stock outstanding. The par value of both stock and bonds outstanding was 64.2 per cent of the total amount of capital—stock and bonds—authorized.

The dividends paid on the common stock amounted to $14,894,787, apparently an average return of 5.5 per cent. This amount, however, was reported by only 636 systems, with a common stock of a par value of $222,228,966, and if it be assumed that dividends were paid by these companies on all the common stock outstanding the average rate becomes 6.7 per cent. It would appear that the capital obligations of the companies were represented largely by the common stock, for the dividends paid on the preferred stock were small, the amount being $86,862, or an apparent average of 1.8 per cent on all such stock. When the preferred stock not paying dividends is eliminated, the par value of that in good standing was only $4,408,596, making an average rate of 2 per cent. Therefore a considerable proportion of the capital of commercial incorporated companies was evidently invested in common stock that received a large share of the net income.

Capitalization of mutual systems.—Of the 994 mutual telephone systems, 347, or 34.9 per cent, were selected for purposes of comparison and considered as incorporated companies. As a matter of fact, many of these were associations that had association or scrip stock, but were not necessarily incorporated under state laws. Hence, strictly speaking, they were not incorporated companies according to the true definition of such companies as applied to commercial systems, but the tendency of these systems as they grow in magnitude and complexity is distinctly toward full commercial incorporation, and they are of interest from a comparative standpoint.

The total value of the outstanding stocks and bonds of the mutual systems was $664,265, or less than one-half of the amount authorized. Of the outstanding capital, only $3,000 was funded debt and all the rest was common stock, there being no preferred stock.

Capitalization of Bell and independent systems.—While some of the independent telephone systems, at the time of the compilation of this report, had been consolidated into groups, each under its own centralized ownership and management, the Bell system was the only one operating throughout the whole country for which authentic figures of capitalization could be presented. The figures of the American Telephone and Telegraph Company are given in Table 15, which shows for each of the allied Bell systems the total par value of the authorized and issued stocks and bonds. In each case, unless otherwise noted, all the stock is common, and the par value is $100. There is a conspicuous absence from the telephone field, as from the telegraph field, of preferred stock as one of the classes of securities.

Table 15.—CAPITALIZATION OF THE AMERICAN TELEPHONE AND TELEGRAPH COMPANY AND ITS LICENSEE COMPANIES: 1902.

NAME OF COMPANY.	State in which operated.	CAPITAL STOCK.		Bonds outstanding.
		Authorized.	Outstanding.	
Total		$414,432,000	$306,627,501	$65,673,272
American Telephone and Telegraph Company		150,000,000	99,008,572	[1] 38,000,000
The Bell Telephone Company of Buffalo	New York	10,000,000	5,000,000	
The Bell Telephone Company of Missouri	Missouri and Illinois	4,000,000	2,646,980	
The Bell Telephone Company of Philadelphia [2]	Pennsylvania	12,000,000	10,979,700	
The Delaware and Atlantic Telephone and Telegraph Company	Pennsylvania, New Jersey, and Delaware	400,000	397,945	
The Central District and Printing Telegraph Company	Pennsylvania, Ohio, and West Virginia	10,000,000	8,750,000	
Central New York Telephone and Telegraph Company	New York	1,000,000	961,500	100,000
Central Union Telephone Company	Ohio, Illinois, and Indiana	10,000,000	5,450,877	6,000,000
The Chesapeake and Potomac Telephone Company	Maryland, District of Columbia, and West Virginia.	2,650,000	2,650,000	1,451,000
Chicago Telephone Company	Illinois and Indiana	15,000,000	11,993,400	
The City and Suburban Telegraph Association [2]	Ohio, Kentucky, and Indiana	4,000,000	3,638,250	
The Cleveland Telephone Company	Ohio	4,000,000	3,100,000	
The Colorado Telephone Company [2]	Colorado	5,000,000	3,400,000	
The Colorado Telephone and Telegraph Company	New Mexico	200,000	200,000	
Cumberland Telephone and Telegraph Company	Tennessee, Kentucky, Mississippi, Louisiana, Illinois, Indiana, and Alabama.	10,000,000	9,353,650	[3] 1,149,000
Duluth Telephone Company [2]	Minnesota and Wisconsin	100,000	100,000	210,000
East Tennessee Telephone Company	Kentucky and Tennessee	300,000	300,000	150,000
The Empire State Telephone and Telegraph Company	New York	250,000	200,000	
Freeport Telephone Exchange Company	Illinois	10,000	10,000	
Hudson River Telephone Company	New York	4,000,000	3,613,200	
Iowa Telephone Company [4]	Iowa and Wisconsin	[5] 4,000,000	[6] 1,425,000	350,000
Knox Telephone and Telegraph Company	Maine	[7] 250,000	[8] 220,000	
Michigan Telephone Company	Michigan	10,000,000	5,000,000	[9] 5,594,400
The Missouri and Kansas Telephone Company	Missouri, Kansas, and Oklahoma	5,000,000	3,102,000	490,000
Nebraska Telephone Company	Iowa, Nebraska, and South Dakota	2,000,000	1,800,000	
New England Telephone and Telegraph Company	Massachusetts, Vermont, New Hampshire, and Maine.	30,000,000	21,616,700	4,000,000
New York and Pennsylvania Telephone and Telegraph Company	New York and Pennsylvania	1,000,000	1,000,000	812,500
New York Telephone Company	New York, New Jersey, and Connecticut	50,000,000	50,000,000	1,700,027
New York and New Jersey Telephone Company	New York and New Jersey	15,000,000	11,435,160	1,283,000
Northern Telephone and Telegraph Company	New Hampshire	10,000	4,000	
Northwestern Telephone Exchange Company [2]	Minnesota, North Dakota, and South Dakota	6,000,000	4,354,300	
Pacific States Telephone and Telegraph Company	California, Idaho, Oregon, and Washington	15,000,000	11,000,000	
Sunset Telephone and Telegraph Company	Arizona, California, Nevada, Oregon, and Washington.	3,000,000	3,000,000	2,799,721
The Pennsylvania Telephone Company [2]	Pennsylvania and New Jersey	3,000,000	2,130,867	593,124
Plymouth and Campton Telephone Exchange Company	New Hampshire	12,000	12,000	
Providence Telephone Company [2]	Rhode Island and Massachusetts	3,000,000	1,600,000	
Rocky Mountain Bell Telephone Company	Utah, Montana, Wyoming, and Idaho	2,500,000	2,200,000	
Southern Bell Telephone and Telegraph Company	Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, and Alabama.	1,000,000	1,000,000	
Southern Massachusetts Telephone Company	Massachusetts	600,000	600,000	200,000
Southern New England Telephone Company	Connecticut	5,000,000	2,990,000	790,500
The Southwestern Telephone and Telegraph Company	Arkansas and Texas	10,000,000	7,316,000	
White Mountain Telephone Company	New Hampshire and Maine	100,000	6,300	
Wisconsin Telephone Company	Wisconsin	5,000,000	3,011,100	
Vermont Telephone and Telegraph Company	Vermont	50,000	50,000	

[1] Includes $10,000,000 in bonds of American Bell Telephone Company.
[2] The par value per share of the stock of this company is $50.
[3] Includes $16,000 in bonds issued by Ohio Valley Telephone Company.
[4] The par value per share of the stock of this company is $25.
[5] Includes $2,725,000 of preferred stock.
[6] Includes $160,925 of preferred stock.
[7] Includes $150,000 of preferred stock.
[8] Includes $120,000 of preferred stock.
[9] Includes $594,400 in bonds issued by Detroit Telephone Company.

The total par value of the outstanding stock of the American Telephone and Telegraph Company and its licensee companies was $306,627,501, and the value of the outstanding bonds was $65,673,272, making a total capitalization of $372,300,773. But in order to show the actual investment, the following duplications must be deducted:

Total	$139,029,837
Stock owned by American Telephone and Telegraph Company in licensee companies	103,381,528
Stock owned by licensee companies in other licensee companies	9,319,960
Bonds owned by American Telephone and Telegraph Company in licensee companies	2,141,000
Stocks and bonds owned by American Telephone and Telegraph Company in other corporations, either foreign corporations or corporations engaged in manufacturing industries not a part of the telephone industry of the United States	24,187,349

When $139,029,837 is deducted from $372,300,773, the remainder is $233,270,936, which may be accepted as the capitalization or investment of the American Telephone and Telegraph Company's systems in the telephone industry in this country. The total outstanding capitalization of the independent systems, including cash investments of unincorporated companies, amounted to $120,921,421, all of which, so far as is known, was invested in the telephone industry. The total capitalization for the two classes of systems is therefore $354,192,357, of which the American Telephone and Telegraph Company's systems contributed 65.9 per cent.

Table 16 shows the total capitalization of the American Telephone and Telegraph Company's systems and the independent systems.

TABLE 16.—*Capitalization of incorporated companies—Bell and independent systems: 1902.*

	Total.	Bell.	Independent.
Number of incorporated companies	2,271	44	2,227
Capital stock and bonds authorized, par value	$542,633,160	$305,896,400	$236,736,760
Capital stock and bonds outstanding, par value	$348,031,058	$233,270,936	$114,760,122
Capital stock:			
Total authorized, par value	$384,534,066	$264,132,000	$120,402,066
Total outstanding, par value	$274,049,697	$198,298,969	$75,750,728
Dividends paid	$14,982,719	$13,714,437	$1,268,282
Common—			
Authorized, par value	$373,852,341	$261,257,000	$112,595,341
Outstanding, par value	$269,180,076	$198,018,044	$71,162,032
Dividends paid	$14,895,857	$13,711,420	$1,184,437
Preferred—			
Authorized, par value	$10,681,725	$2,875,000	$7,806,725
Outstanding, par value	$4,869,621	$280,925	$4,588,696
Dividends paid	$86,862	$3,017	$83,845
Bonds:			
Authorized, par value	$158,099,094	$41,764,400	$116,334,694
Outstanding, par value	$73,981,361	$34,971,967	$39,009,394
Interest paid	$3,511,948	$1,745,334	$1,766,614
Assessments levied	$137,536		$137,536

Assets and liabilities.—The increase in the capitalization of telephone companies has been very rapid during recent years, but the indications of overcapitalization do not appear conspicuously and are hardly likely to do so until part of the modern equipment bought during the earlier independent boom has been retired from use or has undergone reconstruction. It is beyond question that part of such work was done with light, cheap material, since such material was used to a great extent in the initial Bell telephone construction twenty years ago. While low rates were possible in the Bell systems for a time, the renewal account and the increasing burden of capitalization have had their due effect.

In order to determine the real assets and liabilities for the 4,151 commercial and mutual companies considered, the entire business of each company had to be taken into account in making up the balance sheet. Table 17 shows the aggregate of the balance sheets for all the companies, together with similar statistics for the commercial and the mutual systems separately.

TABLE 17.—*Balance sheet for all systems and for commercial and mutual systems: 1902.*

	Total.	Commercial.	Mutual.
Total assets	$452,172,546	$449,485,693	$2,686,853
Construction and equipment	349,287,462	347,743,470	1,543,992
Telephones	17,274,232	16,210,515	1,063,717
Real estate	22,716,538	22,708,634	7,904
Stocks and bonds of other companies	9,938,342	9,938,342	
Machinery, tools, and supplies	9,689,691	9,657,956	31,735
Bills and accounts receivable	30,629,677	30,610,294	19,383
Cash and deposits	12,291,840	12,271,718	20,122
Sundries	344,764	344,764	
Total liabilities	452,172,546	449,485,693	2,686,853
Capital stock	274,049,697	273,388,432	661,265
Bonds	73,981,361	73,978,361	3,000
Cash investment, unincorporated companies	6,161,299	4,571,318	1,589,981
Reserves	31,029,628	31,029,465	163
Bills and accounts payable	44,302,999	44,223,572	79,427
Dividends unpaid	188,067	188,067	
Sundries	1,124,265	834,561	289,704
Surplus	21,335,230	21,271,917	63,313

The value of the construction and equipment of the telephone systems was $349,287,462, or 77.3 per cent of the total assets. The value of the telephones in use was $17,274,232, or 3.8 per cent. The value of the real estate owned was $22,716,538, or 5 per cent. The stocks and bonds of other corporations held were inventoried at $9,938,342, or 2.2 per cent. The other items, comprising machinery, tools and supplies, bills and accounts receivable, cash on hand and on deposit, and sundries, amounted to $52,955,972, or 11.7 per cent of the total.

Of the liabilities, $274,049,697, or 60.7 per cent, represented the capital stock outstanding and $73,981,361, or 16.4 per cent, the outstanding bonds. These two items make a total of $348,031,058. This it may be noted was almost equal to the amount for construction and equipment. To obtain the total value of investments, $6,161,299, the amount of cash investment of unincorporated companies should be added to the outstanding capital. On the other hand, the reserves amounted to $31,029,628 and the surplus to $21,335,230, these two items making a total of $52,364,858, or 11.6 per cent. The unpaid dividends were negligible, being only $188,067, or less than one-tenth of 1 per cent. The liabilities under "sundries" amounted to $1,124,265, or two-tenths of 1 per cent, and included such items as the value of telephones and other apparatus owned by individual subscribers, and additional cash investment for incorporated companies showing stock or bonds.

This balance sheet shows a large surplus, but in several individual cases there were not enough assets to offset the liabilities, and an aggregate deficit of $8,160,810 was reported by 171 systems. This amount was deducted from the surplus shown by the remaining 3,980 systems, in order to present a true balance sheet for the industry as a whole. The deficit appears to have been occasioned largely by the practice, followed by new companies, of giving away stock as an inducement to the purchasers of their bonds; but it was also due in some instances to rapid depreciation of equipment.

Balance sheet for commercial systems.—The total assets for the commercial systems were $449,485,693. Of this, the value of the construction and equipment was $347,743,470, or 77.4 per cent; the value of the telephones owned, $16,210,515, or 3.6 per cent; the value of real estate, $22,708,634, or 5.1 per cent; the par value of stocks and bonds of other corporations, $9,938,342, or 2.2 per cent; the value of machinery, tools, and supplies, $9,657,956, or 2.1 per cent; bills and accounts receivable, $30,610,294, or 6.8 per cent; cash and deposits, $12,271,718, or 2.7 per cent; and sundries, $344,764, or one-tenth of 1 per cent.

Of the total liabilities, the par value of the outstanding capital stock was $273,388,432, or 60.8 per cent; the par value of the outstanding bonds, $73,978,361, or 16.5 per cent; reserves, $31,029,465, or 6.9 per cent; bills and acounts payable, $44,223,572, or 9.8 per cent; unpaid dividends, $188,067, or less than one-tenth of 1 per cent; surplus, $21,271,917, or 4.7 per cent; cash investment, $4,571,318, or 1 per cent; and sundries, $834,561, or two-tenths of 1 per cent.

Of the commercial systems, 143 reported a deficit amounting to $8,147,938. Accordingly, in order to reach the actual condition of the remaining systems, the surplus shown in the foregoing balance sheet should be increased by that amount.

Balance sheet for mutual systems.—The construction and equipment of the mutual systems were valued at $1,543,992, or 57.5 per cent of the total assets; and the telephones used, at $1,063,717, or 39.6 per cent. The other items were individually small. Of the liabilities, $1,589,981, or 59.2 per cent, represented the cash investment of 647 unincorporated systems, and $661,265, or 24.6 per cent, was the outstanding stock of the 347 incorporated companies.

CHAPTER IV.

REVENUE AND EXPENSES.

Revenue.—The total revenue of all telephone systems in 1902, as shown by Table 1, was $86,825,536, while the total operating expenses and fixed charges, exclusive of interest on bonds, was $61,652,823. The interest on bonds amounted to $3,511,948, and the net surplus for the year was $6,678,046.

Table 18 presents the revenue and expense totals for the United States in the form of an income account.

TABLE 18.—*All systems—income account: 1902.*

Gross receipts from operation		[1] $81,599,769
Operating expenses		56,867,062
Net earnings from operation		24,732,707
Income from other sources:		
Dividends on stock of other companies	$268,044	
Lease of lines, wires, and conduits	1,197,476	
Rent from real estate	1,348,894	
Interest	1,359,953	
Miscellaneous	1,051,400	
		5,225,767
Gross income, less operating expenses		29,958,474
Deductions from income:		
Taxes	2,944,281	
Interest—		
Floating debt	1,831,377	
Funded debt	3,511,948	
Paid for leased lines	10,103	
		8,297,709
Net income		21,660,765
Deductions from net income:		
Dividends on preferred stock	86,862	
Dividends on common stock	14,895,857	
		14,982,719
Net surplus for the year		6,678,046

[1] Includes assessments for mutual systems.

As will be noted, the revenue of telephone companies is derived almost wholly from operation, the gross receipts from that source being $81,599,769, or 94 per cent, this including, however, assessments for mutual systems. When the whole revenue of $86,825,536 is treated as the measure of earning capacity, the yearly average income was $37.50 per telephone and 1.7 cents per talk or message. The average income per telephone is much more definite and accurate than that for messages, since every company knows the number of its telephones in use, while the amount of traffic is entirely a matter of estimate, except where the business is on the measured rate footing. When a telephone is installed on a flat rate basis, few subscribers refuse to let their friends use it; whereas, if the instrument is installed on a measured rate basis, its use is much less freely granted.

The total operating expenses amounted to $56,867,062, without the fixed charges and dividends; therefore the average annual expense per telephone was $24.56.

Operating expenses.—Table 19 is an analysis of the operating expenses for all systems.

TABLE 19.—*All systems—analysis of operating expenses: 1902.*

Total	$56,867,062
General operation and maintenance, including legal expenses	49,587,964
Salaries of general and other officers	5,249,890
Salaries of clerks, etc	4,635,996
Wages	26,369,735
Maintenance and legal expenses	13,332,343
Rentals and royalties on instruments and apparatus	2,837,013
Rentals of offices and other real estate	2,498,814
Rentals of conduits and underground privileges	681,727
Telephone traffic paid or due other companies	442,260
Miscellaneous	819,284

From Table 19 it appears that wages alone formed nearly one-half of the total operating expenses, and that salaries and wages combined amounted to not less than $36,255,621, or 63.8 per cent of the total. This seems a large percentage in view of the fact that the work of young women and girls is so considerable a factor in all telephonic intercommunication. The next largest item—$13,332,343, or 23.4 per cent—is that for maintenance and legal expenses, including all expenses for repairs, renewals, and outlays incident to franchises, rights of way, etc.—a rather incongruous grouping for what was essentially engineering work, but it was not possible to differentiate the items more fully. It should be added that the legal expenses were largely made up of "personal injury" cases, due to claims for death or shock from contact with the telephone circuits, and other damage suits of the same character.

Outlay for new construction.—The companies were requested to give separate answers as to new construction during the period of twelve months reported upon, these answers being designed to include the cost of lines, real estate, equipment, etc., added during the year, whether by construction or by acquisition through purchase. It was difficult to make and preserve the distinction between renewals and entirely new constructive additions to the physical property. It is quite probable that in some instances the reported figures for new construction contain some statistics for outlay on mere repairs and renewals, and in other instances the totals reported for "maintenance and legal expenses" include some amounts expended for new construction. The uncertainty as to the division of expenses between these two items was especially apt to occur in cases when wire was given out in bulk for both repairs and extensions and when new poles were set on old lines. On the whole, however, a fair approximation to the facts is presented in Table 20, which gives the total reported cost of new construction, by states and territories.

TABLE 20.—*All systems—cost of additional construction, by states and territories: 1902.*

STATE OR TERRITORY.	Total.	STATE OR TERRITORY.	Total.
United States	$51,903,021	Missouri	$2,501,924
		Montana	170,706
Alabama	571,801	Nebraska	564,456
Arizona	56,484	Nevada	16,840
Arkansas	172,636	New Hampshire	54,742
California	1,779,896	New Jersey	2,153,816
Colorado	951,369	New Mexico	18,892
Connecticut	567,996	New York	7,566,365
Delaware	264,295	North Carolina	373,580
Florida	205,761	North Dakota	71,441
Georgia	874,836	Ohio	2,929,774
Idaho	108,657	Oklahoma	363,415
Illinois	4,472,060	Oregon	249,426
Indian Territory	68,927	Pennsylvania	6,114,696
Indiana	1,780,942	South Carolina	419,546
Iowa	1,841,288	South Dakota	143,891
Kansas	525,406	Tennessee	856,643
Kentucky	1,279,203	Texas	1,232,438
Louisiana	450,660	Utah	303,945
Maine	116,266	Vermont	63,120
Maryland[1]	1,204,109	Virginia	780,328
Massachusetts	2,136,437	Washington	774,230
Michigan	1,399,746	West Virginia	298,414
Minnesota	1,639,824	Wisconsin	832,618
Mississippi	328,960	All other states[2]	250,216

[1] Includes District of Columbia.
[2] Includes Rhode Island and Wyoming.

In spite of the large maintenance account noted, increased, however, by an indeterminate amount of legal expenses, the surprisingly large sum of $51,903,021 was reported as the cost of construction during the census year 1902. If this rate of growth should continue, the investment values in the telephone industry will have more than doubled by 1912. The outlays for new construction were largest in the most populous states, the amounts and proportions being as follows: New York, $7,566,365, or 14.6 per cent; Pennsylvania, $6,114,696, or 11.8 per cent; and Illinois, $4,472,060, or 8.6 per cent.

There is a probability that the cost of real estate constituted a larger proportion of the outlay in 1902 than in earlier years. The practice is growing for telephone companies to purchase real estate and erect appropriate buildings thereon, thus creating an investment and lessening the amount paid out yearly for rent, the practice formerly having been to hire one or two top floors and adapt them to exchange purposes. Thus Table 19 shows an annual payment of $2,498,814 for rent of offices and real estate, while Table 1 shows $22,716,538 as the value of the real estate owned by the 4,151 telephone systems. It is indisputable that this real estate item is growing rapidly, and it is likely, therefore, that rent will not increase seriously as an item of operating expense. Some of the newer telephone exchanges in large cities are handsome buildings, with very desirable rooms as general offices on the floors not occupied by the exchanges, switchboards, etc. In Table 18 an item of $1,348,894 is reported as rent from real estate.

Division of net earnings.—The difference between the gross receipts from operation, $81,599,769, and the operating expenses, $56,867,062, gives $24,732,707 as the net earnings from telephone service proper. These earnings were increased by $5,225,767, the income from other sources. Of this total, $8,297,709 was used to defray the fixed charges, which included taxes, interest on funded and floating debt, and payments for leased lines. These fixed charges amounted to 12.7 per cent of the aggregate expenses, less dividends, as shown in Table 44.

When the fixed charges were deducted from the previous net income, a new net income of $21,660,765 remained, this being an average of $9.36 per telephone. Of this total, $14,982,719 was expended in dividends and $6,678,046 was reserved as net surplus. The dividends paid amounted to 17.3 per cent and the surplus, to 7.7 per cent of the gross revenue. As the capital stock reported was valued at $274,049,697, it would appear that the dividends represented a return of nearly 5.5 per cent. When the company was prosperous, the return to the investor would frequently be better than this, especially in the instances in which the stock was not fully paid or had been issued in part as a bonus with the bonds.

As a matter of fact there were 130 systems that operated at a loss during the year covered by the report, their deficit amounting to $473,419. The net surplus, therefore, of the 4,021 profitable systems was that much more than the total reported for the whole country, or $7,151,465. The general reservation for depreciation and reserve appears to be inadequate, especially in view of the necessity for frequent and entire reconstruction of lines and exchanges, on account of the growth of the industry and the changes in the methods of operation. Some light was thrown upon this point by the report of the Merchants' Association of New York concerning telephone rates in that city. In that report, presented in June, 1905, the case is cited of a company in Baltimore, Md., where the entire original plant, after being in service but five years, was disposed of as junk and $2,155,000 was spent in its replacement. As to New York city it was stated:

> In the New York telephone system improvements and changes have succeeded one another at close intervals during the entire period in which the business of exchange telephone service has existed. During the sixteen years which the committee's investigation covers, the plant had been practically rebuilt three times. At various times radical improvements have been made in cables and in switchboard systems, which have involved the abandonment of plant by no means unserviceable because of its physical condition, and its replacement by plant of an improved character. Some of the central stations have been rebuilt three times within a little over ten years.

These changes are not peculiar to New York, and if regarded as occurring all over the country, it would seem that the percentages of dividend payments and of reserve might well be reversed. The committee of the Merchants' Association gave its opinion as follows:

> To provide a fair return of capital actually and necessarily invested, and a proper allowance for contingencies, 10 per cent margin above operating outlays is a reasonable and proper margin in the telephone business.

Returns for Bell systems.—The returns made for the 43 licensee companies of the American Telephone and Telegraph Company showed an expenditure of $2,631,400, or 92.8 per cent of the $2,837,013 reported in Table 19, as rentals and royalties paid for instruments and apparatus. The telephones used by the Bell licensee companies and their subscribers are the property of the American Telephone and Telegraph Company, which furnishes to such licensees its standard instruments, renewing them without expense to the operating company and replacing them with improved instruments from time to time. The income of the parent company from this source is included in the gross receipts from operation. The remaining items shown in Table 19 were common to the operation of all telephone systems. The licensing or hiring of telephonic apparatus on a rental basis is peculiar to the Bell system, and is not practiced among the independent companies, all of which are understood to have bought their apparatus outright; so that, unless there is an agreement to exchange old apparatus for new, the acquisition of improved appliances involves fresh outlay on the part of the local exchange system.

The capitalization of the Bell system is reported in Table 16, where the total stock issued is given as $198,298,969, and the dividends paid as $13,714,437, or 6.9 per cent. This table shows also that the stock of the independent companies was outstanding to the amount of $75,750,728, and on this stock the payment of dividends was at the rate of 1.7 per cent. It should be borne in mind that the Bell system as a whole has been in existence over twenty years, while the independent companies are still in a general way in the initial period. Another reason for the discrepancy in apparent earning power is the fact that the Bell exchanges have had the advantage, having naturally occupied at the outset the larger centers of population.

Revenue and expenses of large systems.—The concentration of the telephone industry in the larger centers of population is strikingly indicated by Table 21.

TABLE 21.—*Revenue and expenses of all systems and of systems having 1,000 telephones and over: 1902.*

	All systems.	Systems having 1,000 telephones and over.	Per cent of all systems.
Number of systems	4,151	194	4.7
Number of telephones	2,315,297	1,679,199	72.5
Gross receipts from operation	$81,599,769	$71,374,134	87.5
Income from other sources	$5,225,767	$5,193,807	99.4
Operating expenses	$56,867,062	$50,806,748	89.3
Fixed charges	$8,297,709	$7,562,950	91.1
Dividends paid	$14,982,719	$14,357,918	95.8
Net surplus	$6,678,046	$3,840,325	57.5

In 1902 only 194 systems had 1,000 or more telephones; yet these few systems were serving somewhat more than half the population of the country. They had 1,679,199 sets of instruments, the average being no fewer than 8,656 telephones per system. Of course the average per system would be lower if the 12 leading cities were excluded, as the average for them was 31,450 telephones, while for the remaining 182 systems it was 7,207 telephones.

Although these 194 systems constituted only 4.7 per cent of all telephone systems, they operated 72.5 per cent of the telephones shown for all systems. The gross receipts from operation for these systems aggregated $71,374,134, or 87.5 per cent of the total for the United States. Their income from other sources was $5,193,807, or 99.4 per cent of the amount of such revenue. Their operating expenses were $50,806,748, and their fixed charges, $7,562,950—89.3 per cent and 91.1 per cent of the respective totals. The dividends paid by these systems amounted to $14,357,918, or 95.8 per cent of the dividends paid by all systems. The surplus for the year reported by these large systems was $3,840,325, or 57.5 per cent of the net surplus of all telephone systems. Eleven of these 194 systems operated at a loss during the year covered by this report, the total deficit amounting to $217,527; hence the actual surplus for the 183 earning companies was $4,057,852. In the case of all but 2 of the 11 companies operating at a loss the deficit was due to the high fixed charges; with the 2 it was caused by the payment of a higher rate of dividend than the yearly net income warranted. The fact that so small a proportion of the companies controlled so great a percentage of the telephone business of the country shows the strong tendency toward concentration.

Revenue and expenses, by states.—Table 44 gives the details of revenue and expenses by states and territories. As will be seen, New York state was by far the most productive as to revenue, having $16,352,193, or 18.8 per cent of the total, while the operating expenses and fixed charges were large, amounting to $10,933,934, or 16.7 per cent of the aggregate. Next in magnitude was Pennsylvania, with a revenue of $8,083,896 and expenses and fixed charges amounting to $6,315,052; Illinois ranked third, with $7,308,885 and $5,537,793 as the corresponding totals. The totals for Ohio and Massachusetts were similar, the former having a revenue of $6,192,640 and operating expenses and fixed charges of $4,815,675, and the latter having a revenue of $6,127,452 and corresponding expenses amounting to $4,810,043. California stood high in the list, with a revenue of $4,091,076 and operating expenses and fixed charges of $3,430,662. These six states accounted for $48,156,142, or more than half of the revenue, and $35,843,159, or more than half of the expenses. Large amounts were reported also for the following states: Missouri, $2,970,597 and $2,114,071; Indiana, $2,816,509 and $2,164,064; Texas, $2,485,925 and $1,804,324; and Michigan, $2,444,051 and $2,208,955, the totals being respectively for revenue and expenses including operating expenses and fixed charges. Although Iowa had the largest number of systems, 411, her totals are well down the list, being $1,962,362 for revenue and $1,401,824 for operating expenses and fixed charges—a sharp contrast with Massachusetts, which reported only 10 systems as doing its vast telephone business.

The conditions with regard to revenue and expenses prevailing in the different states can also be ascertained from Table 44. For instance, the total amount of revenue derived from dividends on stock held as investment was $268,044, of which $221,810, or 82.8 per cent, was reported for New York state. The revenue derived from leasing lines, wires, and conduits to other telephone systems and to outside parties amounted to $1,197,476. Of this amount, the group of adjoining states comprising Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, Ohio, Indiana, and Illinois reported $1,072,647,or 89.6 per cent, Pennsylvania alone contributing $284,332, or 23.7 per cent. Nineteen of the states and territories reported no revenue from this source. Of the $1,348,894 derived from real estate rentals, $545,159, or 40.4 per cent, was reported for New York. All the states and territories except New Mexico contributed to the total for this item of revenue. Interest on investments in other companies amounted to $1,359,953, of which $402,155, or 29.6 per cent, was reported from New York state. For both interest and "miscellaneous" Indian Territory alone shows no revenue.

Revenue and expenses of commercial systems.—Table 49 shows, by states and territories, a detailed revenue and expense account for commercial systems. Table 22 summarizes the totals in the form of an income account.

TABLE 22.—*Commercial systems—income account: 1902.*

Gross receipts from operation		$81,296,444
Operating expenses		56,591,746
Net earnings from operation		24,704,698
Income from other sources:		
Dividends on stock of other companies	$268,044	
Lease of lines, wires, and conduits	1,197,476	
Rent from real estate	1,348,894	
Interest	1,359,953	
Miscellaneous	1,051,400	
		5,225,767
Gross income less operating expenses		29,930,465
Deductions from income:		
Taxes	2,940,430	
Interest—		
Floating debt	1,829,074	
Funded debt	3,511,768	
Paid for leased lines	9,752	
		8,291,024
Net income		21,639,441
Deductions from net income:		
Dividends on preferred stock	86,862	
Dividends on common stock	14,894,787	
		14,981,649
Net surplus for the year		6,657,792

The total revenue derived by commercial telephone systems from all sources was $86,522,211, or an average of $38.87 per telephone. Of this amount, $81,296,444, or 94 per cent, was realized from the actual operation of the commercial telephone systems. The net income was $21,639,441, or an average of $9.72 per telephone, which average was, therefore, somewhat higher than the average of $9.36 for all systems.

The total operating expenses amounted to $56,591,746, or $25.42 per telephone. The fixed charges and dividends deducted from gross receipts amounted to $23,272,673, or $10.46 per telephone. Hence the total net surplus, after deducting charges of all kinds, was $6,657,792, an average per telephone of $2.99, as compared with $2.88 for all systems.

Table 23 is an analysis of the operating expenses of commercial systems.

TABLE 23.—*Commercial systems—analysis of operating expenses: 1902.*

Total	$56,591,746
General operation and maintenance, including legal expenses	49,332,620
Salaries of general and other officers	5,236,323
Salaries of clerks, etc	4,635,273
Wages	26,206,065
Maintenance, and legal expenses	13,254,959
Rentals and royalties on instruments and apparatus	2,832,361
Rentals of offices and other real estate	2,492,676
Rentals of conduits and underground privileges	681,727
Telephone traffic paid or due other companies	436,666
Miscellaneous	815,696

Of the operating expenses of commercial companies, salaries and wages together constituted $36,077,661, or 63.8 per cent; maintenance and legal expenses, $13,254,959, or 23.4 per cent; rentals and royalties on instruments and apparatus, $2,832,361, or 5 per cent; rentals of offices and other real estate, $2,492,676, or 4.4 per cent; miscellaneous items, $815,696, or 1.4 per cent; rentals of conduits and underground privileges, $681,727, or 1.2 per cent; and the amount paid or due other companies for telephone traffic, $436,666, or eight-tenths of 1 per cent.

Revenue and expenses of mutual systems.—There were, all told, 994 mutual telephone systems, and for these Table 51 shows a detailed revenue and expense account, by states and territories. In Table 24 the totals are summarized in the form of an income account.

TABLE 24.—*Mutual systems—income account: 1902.*

Gross receipts from operation		$165,789
Operating expenses		275,316
Deficit from operation		109,527
Assessments		137,536
Gross income less operating expenses		28,009
Deductions from income:		
Taxes	$3,851	
Interest—		
Floating debt	2,303	
Funded debt	180	
Paid for leased lines	351	
		6,685
Net income		21,324
Dividends on common stock		1,070
Net surplus for the year		20,254

The actual revenue derived by mutual systems from operation was $165,789, and the operating expenses amounted to $275,316, causing an operating deficit of $109,527. The gross receipts from operation averaged

$1.86 per mutual telephone, while the operating expenses averaged $3.08; the operating deficit, therefore, was $1.22 per telephone. In addition to the operating deficit, the fixed charges were $6,685, making a total deficit of $116,212, which was covered by assessment. The assessments amounted to $137,536, or 45.3 per cent of the total revenue, and, after the deduction of the $1,070 paid in dividends by the 7 companies declaring dividends, a net surplus of $20,254 was left.

In only 19 of the 30 states and territories reporting three or more systems did the actual revenue exceed the assessments, and in only 1 state, Maryland, was there no assessment. The 3 mutual systems in North Dakota were supported entirely by assessment.

The operating expenses of the mutual systems are segregated in Table 25.

TABLE 25.—*Mutual systems—analysis of operating expenses: 1902.*

Total	$275,316
General operation and maintenance, including legal expenses	255,344
Salaries of general and other officers	13,567
Salaries of clerks, etc	723
Wages	163,670
Maintenance and legal expenses	77,384
Rentals and royalties on instruments and apparatus	4,652
Rentals of offices and other real estate	6,138
Telephone traffic paid or due other companies	5,594
Miscellaneous	3,588

Of the operating expenses for mutual systems, salaries and wages together amounted to $177,960, or 64.7 per cent; maintenance and legal expenses to $77,384, or 28.1 per cent; rentals of offices and other real estate to $6,138, or 2.2 per cent; the amount paid or due other companies for telephone traffic to $5,594, or 2 per cent; rentals and royalties on instruments and apparatus to $4,652, or 1.7 per cent; and miscellaneous items to $3,588, or 1.3 per cent.

CHAPTER V.

TELEPHONE TRAFFIC.

Nature of traffic.—In telegraphic and telephonic parlance the word "traffic" is used to designate the amount of business, or number of messages. Each message that a subscriber sends is usually termed an originating call. When a message passes over a trunk line connecting two exchanges in a single system, it is termed a trunk call. The functions of the operator are usually as follows: When the subscriber turns the handle of the magneto generator in his telephone set or lifts the receiver from the hook, a signal is displayed at the end of the subscriber's line in the switchboard in front of an operator, usually termed an "A" operator. The operator on observing this signal picks up a brass plug attached to a flexible cord and inserts the plug into a spring jack, which forms the end of the subscriber's line in the face of the switchboard. The jack and plug are so constructed that when the plug is inserted the conductors of the subscriber's line make contact with corresponding conductors in the attached cord. The operator by pressing a key connects a receiver strapped upon her ear and a transmitter suspended in front of her to the cord, and then communicates with the subscriber by pronouncing the familiar phrase, "Number, please," or an equivalent request. In response the subscriber designates the desired correspondent by giving first the name of the office or exchange in which the subscriber's line is located, and then the number. The simplest case occurs when the wire of the subscriber called for runs into the same exchange as the wire of the one calling. Then the operator picks up a second plug connected to the one already inserted in the calling subscriber's jack, and makes a test to ascertain whether or not the line called for is engaged for other conversation, by touching the tip of the plug to the spring jack of the desired line. In case the line is engaged, this action causes the operator's receiver to emit a sharp click, while if the line is free no such sound is produced. In case the line is busy, the operator so informs the subscriber; if it is found disengaged, she inserts the plug into the spring jack, thus joining the two interlocutors, and rings the second subscriber by pressing a key which makes connection with a small dynamo machine that furnishes ringing current over the line of the subscriber to be called. If the desired subscriber is not located in the same central office or exchange, the operator must transfer the call to another office. This is done by providing between the offices pairs of wires, usually called order wires. The A operator presses a key which connects her telephone to an order wire leading to the receiver at the ear of an incoming trunk operator (B operator) in the office desired, and pronounces the number of the subscriber to be called. In reply, the B operator in the other office pronounces a number back to the A operator over the order wire; this number is the designation of the trunk line that the A operator is to use. The A operator inserts the plug in a jack connected to this trunk line. This completes the work of the A operator. The B operator, upon the reception of the order given by the A operator, selects a plug connected by a cord to the trunk line that has been designated, and tests the jack of the subscriber to be called. If it is disengaged, she inserts the plug into the jack and rings. Connected with the cords used to join subscribers for conversation are clearing-out signals, whose object is to notify the operators as soon as the subscribers have finished with the line. When the operators notice the display of the disconnect signals, they remove the plugs from the spring jacks, leaving the lines free again.

Definition of message.—Messages are defined as being local, long distance, or toll. A local message is usually one that is conveyed within the city in which the calling subscribers are located. A toll message is a message traveling between two public exchanges that belong to the same system, but are, as a rule, located in different towns. A long distance message is one that passes between the exchanges of two different systems. These definitions fail to recognize the fact that different telephone systems handle these classes of connections in various ways, but the classification of the individual system making the report has been accepted.

Traffic statistics.—In considering traffic statistics it must be remembered that the quantity of traffic is very largely estimated and in the nature of things can not be exact. It has become a custom with most of the telephone companies to make an actual count of the messages handled by each of the offices during a period of twenty-four hours once each month. The probable yearly business is computed from the statistics thus obtained by multiplying the average of the various monthly counts by the number of days in the year after a proper allowance has been made for holidays. As some companies do not make such traffic investigations, or fail to report them, it seems probable that the number of messages indicated in the preceding tables is slightly underestimated.

For continental United States in 1902, Table 5 shows a total of 5,070,554,553 messages or talks, which makes an average of 2,190 messages per telephone. These statistics do not include any of the traffic over the 4,985 independent farmer or rural lines, since no records of traffic were kept for these circuits and consequently a mere guess would be the only means of estimating the business they transact.

This table shows that the local messages formed 97.6 per cent, and the long distance and toll messages 2.4 per cent, of the total messages; that the commercial messages and the mutual messages were 98 per cent and 2 per cent, respectively, of the total messages; and that the commercial and mutual long distance and toll messages were 99.4 per cent and six-tenths of 1 per cent, respectively, of the total toll and long distance messages. In other words, the mutual business amounted to about 2 per cent of the total telephone business of the country, and apparently was of correspondingly small importance. It should be remembered, however, that the mutual telephone lines serve communities in which the business is insufficient to cause the investment of capital in large exchanges, and which, if it were not for this means of communication, would be more or less isolated. It is common for the mutual lines to secure some connection with the larger commercial systems, thus keeping the communities in which they are located in a much closer touch with the rest of the country than would otherwise be possible; hence they produce a certain psychological effect of far greater value than can be represented by the mere dollars and cents paid for the traffic that they handle.

The 9 systems in Alaska, the Philippines, and Hawaii reported 3,887,925 messages.

Distribution of telephone stations.—The kind of telephone facilities offered has a bearing on the traffic, because "facilities breed traffic." Thus the "party line," used in common by several subscribers, by placing a telephone service at a moderate price within the reach of the small user, has secured a large traffic that would otherwise be lost. Similarly the handiness of public pay stations presents a temptation to use the telephone that is certainly hard to resist. Table 26, which shows by geographic divisions the distribution of public stations and single and party lines, indicates that the great traffic of some divisions is the result of the inducements offered.

TABLE 26.—*All systems—average population per telephone station, by geographic divisions: 1902.*

DIVISION.	Estimated population.	AVERAGE POPULATION PER—		
		Public station.	Single circuit and private branch exchange station or telephone.	Party line station or telephone.
United States	78,576,436	972	59	89
North Atlantic	21,778,196	448	83	65
South Atlantic	10,770,414	1,451	110	285
North Central	27,087,206	1,111	37	82
South Central	14,651,535	2,044	88	285
Western	4,289,085	1,191	57	33

There was a public or pay station for every 972 persons in the United States, while for every 59 persons there was a private telephone, either on a single circuit or in a private branch exchange, and for every 89 persons there was a telephone on a party line. In the North Atlantic division the number of pay stations in proportion to the population was nearly twice as great as the corresponding number for the whole United States, and considerably more than twice as great as that for any other division. The greatest development is shown for the party line stations in the Western division, where there was one such station for every 33 inhabitants. The North Atlantic division ranked second with one party line station for 65 inhabitants, while in the South Atlantic and South Central divisions there was only one party line station for every 285 inhabitants.

Traffic, by geographic divisions.—The North Central division reported the greatest population, or 34.5 per cent of the whole; the largest number of telephones, or 47.1 per cent of the total number; and the most messages, or 48.3 per cent of the entire traffic of continental United States. In this division the proportion of 25 people per telephone was next to the lowest, the Western division showing only 21; the messages per capita were the greatest, being 90; and the messages per telephone were third in rank, numbering 2,242, while the South Central division reported 3,015 and the South Atlantic 2,467. The Western division showed actually and relatively less population and less traffic than any other.

The relation between the traffic of the commercial and mutual systems by geographic divisions is shown in Table 27.

Fig. 1.—Substation open.

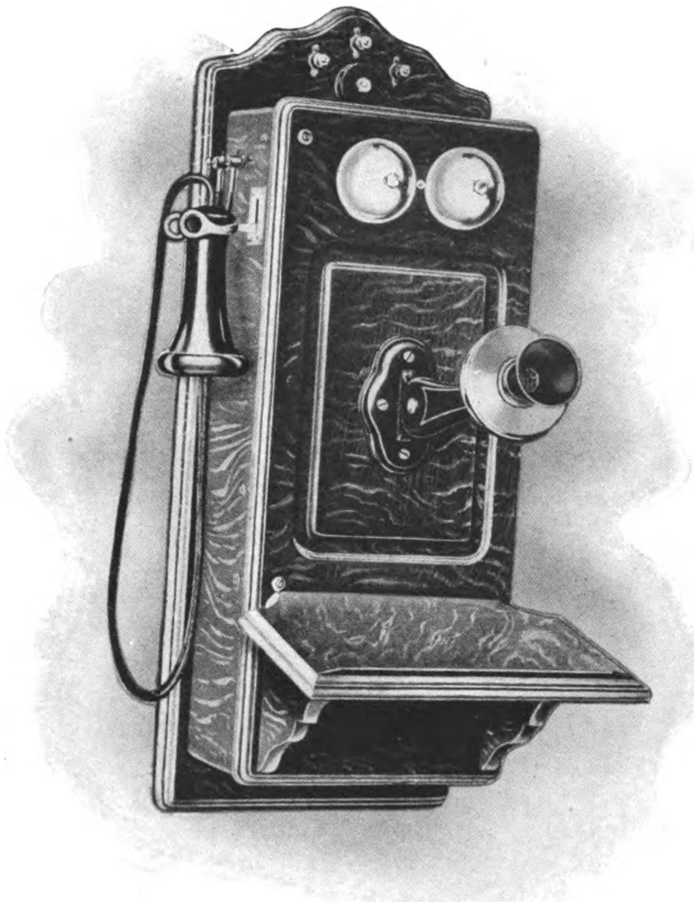


Fig. 2.—Substation closed.

A MAGNETO SUBSTATION.

TABLE 27.—*Messages—commercial and mutual systems, by geographic divisions: 1902.*

DIVISION.	NUMBER OF MESSAGES.		
	Total.	Commercial.	Mutual.
United States	5,070,554,553	4,971,413,070	99,141,483
North Atlantic	1,208,179,198	1,203,979,018	4,200,180
South Atlantic	353,559,870	349,373,521	4,186,349
North Central	2,446,257,875	2,361,506,911	84,750,964
South Central	681,497,626	677,517,694	3,979,932
Western	381,059,984	379,035,926	2,024,058

While the North Central division returned the greatest number of both commercial and mutual messages, giving 2,361,506,911 for the one and 84,750,964 for the other, it is noticeable that the commercial messages were about twice as many as were reported for the North Atlantic division, which ranked second, while the mutual messages were twenty times as many as were reported for any other division. In fact, the North Central division returned about six times as many mutual messages as all other divisions put together.

The greatest average number, 3,031, of commercial messages per telephone was reported for the South Central division; the least, 1,840, is shown for the Western. The North Atlantic averaged 1,872, the South Atlantic, 2,508, and the North Central, 2,329.

The mutual systems reported 99,141,483 messages, but it is probable that the returns for these systems are much less reliable than those for the commercial ones, since few counts of messages are made by the mutual systems and it is difficult for them to make accurate estimates when little or no revenue is derived from the use of the line. The average number of messages per telephone was 1,110 for the year, or over three per day for a year of 325 working days. On the same basis the average number of talks per telephone per day for all systems in the United States was nearly seven, or about twice as great as the average for the mutual systems. But since most of the mutual systems are open for only a few hours on Sundays and holidays, and only an hour or two each night, while most of the commercial systems are open all the time, it is unfair to compute daily averages for the two classes of systems on the same basis. A year of 300 working days may be taken as a more just one for mutual systems, and using this, the average number of messages per telephone per day was nearly four.

The diffusion of telephonic facilities is one measure of the popularity of the service. This is indicated by population per telephone and also by messages per capita. Yet neither of these reflects the importance of the traffic, for one message from New York to Chicago may be of more value, cost more, and involve greater consequences than a thousand sent within the limits of a small town.

Table 28 shows the distribution, by geographic divisions, of local and of long distance and toll business.

TABLE 28.—*All systems—average number of local and of long distance and toll messages per telephone, by geographic divisions: 1902.*

DIVISION.	Stations or telephones of all kinds.	NUMBER OF MESSAGES PER TELEPHONE.		
		Total.	Local.	Long distance and toll.
United States	2,315,297	2,190	2,138	52
North Atlantic	647,670	1,865	1,773	92
South Atlantic	143,314	2,467	2,430	37
North Central	1,091,168	2,242	2,206	36
South Central	225,999	3,015	2,969	46
Western	207,146	1,840	1,810	30

The least number of local messages per telephone—1,773—and the greatest number of toll and long distance messages—92—were reported for the North Atlantic division. The number of toll and long distance calls for this division was double that for any other division and almost double the number for the whole United States. This is due partly to the concentration of business on the North Atlantic seaboard.

Traffic, by states and territories.—A more detailed analysis by states and territories of the total messages and the proportion of local and of toll and long distance business will be found in Table 43. From this table it is seen that in the total number of messages, Ohio led with 558,707,801; Illinois was next, with 541,161,932; while Nevada was last, with 1,409,134. In long distance and toll traffic Pennsylvania was first, with 20,409,621 messages; New York a close second, with 20,367,024; while Nevada was last, with 46,052. The greatest number of local messages, 547,238,743, was reported for Ohio, and the next largest, 535,744,349, for Illinois.

Traffic of commercial and mutual systems.—Tables 29 and 30 show, by states and territories, the amount of traffic for commercial systems and mutual systems separately.

Table 29.—COMMERCIAL SYSTEMS—ANALYSIS OF PHYSICAL EQUIPMENT AND MESSAGES, BY STATES AND TERRITORIES: 1902.

STATE OR TERRITORY.	Number of systems.	Number of stations or telephones.	MILES OF WIRE.			PARTY LINES.			SWITCHBOARDS.		NUMBER OF MESSAGES OR TALKS. Long distance and toll.		Local.	
			Total.	Per system.	Per station.	Number.	Stations.	Stations per line.	Number.	Stations per board.	Total.	Per station per year (325 days).	Total.	Per station per day.
United States..	3,157	2,225,981	4,779,571	1,514	2.15	248,908	808,571	3.3	9,954	224	119,996,531	53.9	4,851,416,539	6.7
Alabama [1]	43	13,968	32,558	757	2.33	1,329	3,022	2.3	70	199	491,059	35.1	45,558,699	10.0
Arizona [1]	10	3,187	3,842	384	1.21	295	1,136	3.9	29	110	67,833	21.3	4,884,894	4.7
Arkansas [1]	76	16,892	24,190	318	1.43	19,652	1,617	2.5	125	135	774,946	45.9	35,941,937	6.5
California	12	106,181	143,469	11,956	1.35	19,635	66,702	3.4	372	285	2,407,043	22.7	175,043,649	5.1
Colorado	10	24,505	52,045	5,205	2.12	4,256	16,303	3.8	96	255	1,531,309	62.5	58,706,204	7.4
Connecticut	5	22,449	56,171	11,234	2.50	4,456	18,615	4.2	45	499	1,515,577	67.5	34,381,525	4.7
Delaware [1]	3	4,293	10,690	3,563	2.49	947	2,117	2.2	21	204	176,564	41.1	8,786,328	6.3
Florida [1]	23	8,172	16,458	716	2.01	411	943	2.3	39	210	165,686	20.3	18,668,341	7.0
Georgia	72	25,380	53,512	743	2.11	2,395	5,618	2.4	118	215	575,818	22.7	95,503,748	11.6
Idaho [1]	6	3,802	6,231	1,039	1.64	456	1,615	2.4	33	115	228,546	60.1	6,171,216	5.0
Illinois	243	194,356	407,357	1,676	2.10	20,660	66,475	3.2	782	249	5,355,721	27.6	510,859,240	8.1
Indian Territory	37	5,331	5,227	141	.98	43	113	2.6	55	97	223,848	42.0	8,114,111	4.7
Indiana [1]	261	122,799	200,379	768	1.63	7,787	31,087	4.0	538	228	4,001,492	32.6	281,296,040	7.0
Iowa	241	98,662	121,851	505	1.24	4,932	17,649	3.6	561	176	3,142,086	31.8	169,636,333	5.3
Kansas [1]	16[illegible]	40,317	51,699	321	1.28	1,292	4,383	3.4	258	156	1,047,185	26.0	57,125,113	4.4
Kentucky [1]	84	45,195	153,278	1,825	3.39	4,264	11,118	2.6	197	229	1,275,009	28.2	140,554,810	9.6
Louisiana [1]	14	17,502	49,359	3,526	2.82	2,543	6,958	2.7	62	282	475,607	27.2	67,601,308	11.9
Maine	23	13,939	25,358	1,103	1.82	2,349	11,493	4.9	112	124	895,025	64.2	20,912,890	4.6
Maryland [2]	16	32,038	97,056	6,066	3.03	5,427	12,214	2.3	90	356	1,284,094	40.1	60,676,787	5.8
Massachusetts	10	96,512	257,461	25,746	2.67	15,034	69,922	4.7	235	411	9,814,424	101.7	173,300,896	5.5
Michigan	77	90,591	194,185	2,522	2.14	4,983	13,208	2.7	479	189	3,745,582	41.3	230,770,258	7.8
Minnesota	120	59,871	134,557	1,121	2.25	7,175	17,181	2.4	274	219	2,527,645	42.2	108,937,117	5.6
Mississippi [1]	32	15,031	29,383	318	1.95	1,457	3,730	2.6	94	160	511,405	34.0	59,858,306	12.3
Missouri	227	82,409	158,724	699	1.93	4,615	15,911	3.5	387	213	2,871,444	34.8	226,973,088	8.5
Montana [1]	4	5,390	8,397	2,099	1.56	956	3,169	3.3	32	168	246,747	45.8	11,072,729	6.3
Nebraska	74	34,509	51,055	690	1.48	2,904	10,589	3.7	199	173	1,210,179	35.1	69,939,928	6.2
Nevada [1]	6	1,143	1,220	203	1.07	205	803	3.9	10	114	44,792	39.2	1,341,082	3.6
New Hampshire	16	9,949	18,390	1,149	1.85	1,648	7,446	4.5	87	114	764,204	76.8	16,222,808	5.0
New Jersey [1]	28	48,980	136,617	4,879	2.79	7,618	28,236	3.7	249	197	4,783,047	97.7	51,388,176	3.2
New Mexico [1]	12	2,481	3,283	274	1.32	54	177	3.3	12	207	36,260	14.6	4,261,660	5.3
New York	179	243,166	621,315	3,471	2.56	27,316	86,200	3.7	691	352	20,341,663	83.7	337,296,703	4.3
North Carolina [1]	71	15,871	24,047	339	1.52	559	1,544	2.8	124	128	441,901	27.8	35,450,097	6.9
North Dakota [1]	29	6,691	9,492	327	1.42	847	1,701	2.0	47	142	351,547	52.5	13,664,186	6.3
Ohio	236	216,731	511,118	2,166	2.36	18,467	60,541	3.3	796	272	11,421,357	52.7	540,922,794	7.7
Oklahoma [1]	23	10,335	16,136	702	1.56	22	66	3.0	76	136	459,976	44.5	22,819,692	6.8
Oregon [1]	16	20,616	29,058	1,816	1.41	3,426	12,229	3.6	114	191	523,403	25.4	34,320,265	5.1
Pennsylvania	77	185,089	500,219	6,496	2.70	36,016	95,223	2.6	862	215	20,382,847	110.1	471,810,398	7.8
South Carolina [1]	36	10,283	18,288	508	1.78	575	1,582	2.8	89	116	385,633	37.5	23,347,281	7.0
South Dakota [1]	47	10,046	10,560	225	1.05	1,063	2,768	2.6	105	96	541,932	53.9	17,132,672	5.2
Tennessee	30	35,007	84,512	2,817	2.41	3,320	8,648	2.6	151	232	1,062,801	30.4	124,932,918	11.0
Texas	157	64,246	140,005	892	2.18	4,911	14,211	2.9	346	186	5,210,998	81.1	161,650,264	7.7
Utah	5	5,734	9,866	1,973	1.72	979	4,132	4.2	22	261	277,762	48.4	11,477,368	6.2
Vermont	31	11,939	16,257	524	1.36	2,039	8,895	4.4	103	116	534,483	44.8	18,377,414	4.7
Virginia [1]	65	21,789	42,454	653	1.95	1,610	3,905	2.4	124	176	748,318	34.3	62,462,408	8.8
Washington [1]	4	31,447	43,027	10,757	1.37	5,910	20,543	3.5	140	225	755,100	24.0	63,868,882	6.2
West Virginia [1]	62	21,493	55,322	892	2.57	1,577	6,254	4.0	163	132	1,420,323	66.1	39,280,194	5.6
Wisconsin	140	57,182	106,273	759	1.86	7,737	23,466	3.0	304	188	2,552,297	44.6	95,481,675	5.1
All other states [3]	3	12,482	37,620	12,540	3.01	1,756	7,113	4.1	36	347	394,013	31.6	22,632,107	5.6

[1] Contains data for system credited to and operating in an adjoining state.
[2] Includes District of Columbia.
[3] Includes systems distributed as follows: Rhode Island, 2; Wyoming, 1.

TABLE 30.—MUTUAL SYSTEMS—ANALYSIS OF PHYSICAL EQUIPMENT AND MESSAGES, BY STATES AND TERRITORIES: 1902.

STATE OR TERRITORY.	Number of systems.	Number of stations or telephones.	MILES OF WIRE.			PARTY LINES.			SWITCHBOARDS.		NUMBER OF MESSAGES OR TALKS.			
											Long distance and toll.		Local.	
			Total.	Per system.	Per station.	Number.	Stations.	Stations per line.	Number.	Stations per board.	Total.	Per station per year (325 days).	Total.	Per station per day.
United States	994	89,316	70,915	71	.79	9,258	77,581	8.4	942	95	708,313	7.9	98,433,170	3.4
Alabama	4	109	101	25	.93	18	109	6.1	2	55	1,185	10.9	108,000	3.1
California	6	393	923	154	2.35	48	359	7.5	4	99	21,197	53.9	812,511	6.4
Colorado	3	28	70	23	2.50	3	28	9.3	......	......	320	11.4	20,700	2.3
Georgia	6	110	177	29	1.61	13	109	8.4	2	55	3,080	28.0	109,420	3.1
Illinois	138	16,831	13,308	96	.79	1,536	14,078	9.2	163	103	61,862	36.8	24,885,109	4.5
Indiana	105	9,690	9,220	88	.95	1,613	8,581	5.3	112	97	76,570	7.9	9,283,463	2.9
Iowa	170	21,355	13,261	78	.62	1,754	18,255	10.4	168	127	156,008	7.3	20,120,311	2.9
Kansas	11	655	650	59	.99	61	615	10.1	8	82	7,954	12.1	518,891	2.4
Kentucky	35	1,071	1,308	37	1.22	116	1,006	8.7	7	153	10,811	10.1	1,260,934	3.6
Maine	4	106	77	19	.73	11	104	9.5	......	......	......	......	116,000	3.4
Maryland	4	52	81	20	1.56	18	43	2.4	5	10	700	13.5	57,500	3.4
Michigan	33	3,370	2,335	71	.69	303	3,001	9.9	44	77	38,015	11.3	3,141,257	2.9
Minnesota	31	2,168	1,799	58	.83	162	1,932	11.9	16	136	10,580	4.9	1,648,920	2.3
Mississippi	3	38	70	23	1.84	3	27	9.0	1	38	250	6.6	45,000	3.6
Missouri	90	10,962	8,564	95	.78	1,173	9,209	7.9	120	91	81,046	7.4	12,383,649	3.5
Nebraska	32	1,644	1,656	52	1.01	201	1,502	7.5	23	71	24,165	14.7	2,052,758	3.8
New York	88	2,849	1,593	18	.56	243	2,610	10.7	44	65	25,361	8.9	2,434,396	2.6
North Carolina	12	381	633	52	1.66	52	325	6.3	6	64	4,225	11.1	589,175	4.8
North Dakota	3	71	40	13	.56	3	11	3.7	2	36	1,000	14.1	90,000	3.9
Ohio	49	6,036	3,516	72	.58	703	5,803	8.3	71	85	47,701	7.9	6,315,949	3.2
Oregon	5	556	435	87	.78	70	501	7.2	6	93	125	.2	933,445	5.2
Pennsylvania	20	1,483	1,199	60	.81	213	1,182	5.5	28	53	26,774	18.1	1,397,699	2.9
South Carolina	6	184	333	55	1.81	40	154	3.9	4	46	1,000	5.4	160,000	2.7
South Dakota	7	259	225	32	.87	18	188	10.4	3	86	3,398	13.1	241,602	2.9
Tennessee	13	1,053	1,683	129	1.60	113	651	5.8	11	96	2,150	2.0	2,276,850	6.7
Texas	12	164	478	40	2.91	32	135	4.2	2	82	2,312	14.1	215,440	4.0
Vermont	6	173	106	17	.61	30	172	5.7	1	173	150	.9	163,800	2.9
Virginia	22	2,341	2,218	101	.95	197	2,153	10.9	22	106	26,702	11.4	2,257,198	3.0
West Virginia	21	883	1,062	50	1.20	94	755	8.0	22	40	9,143	10.4	896,231	3.1
Wisconsin	43	3,963	3,263	76	.82	388	3,763	9.7	40	99	61,969	15.6	3,496,787	2.7
All other states and territories[1]	12	338	531	44	1.57	29	220	7.6	5	68	2,560	7.6	398,175	3.6

[1] Includes systems distributed as follows: Arizona, 1; Connecticut, 1; Florida, 2; Idaho, 1; Louisiana, 1; Montana, 2; Nevada, 2; Oklahoma, 1; Wyoming, 1.

The largest number of commercial local messages, 540,922,794, was reported for Ohio, and the greatest number of commercial long distance and toll messages, 20,382,847, for Pennsylvania. The greatest number of local mutual messages, amounting to 24,885,109, is shown to have been reported for Illinois, and the greatest number of mutual long distance and toll messages, aggregating 156,008, for Iowa.

For the commercial systems the greatest number of toll and long distance messages per station per year was returned for Pennsylvania, the number being 110.1, while the least number, amounting to 14.6, was shown for New Mexico. The highest number of local messages per telephone per day for commercial systems, amounting to 12.3, was in Mississippi, while the least number, 3.2, was found in New Jersey. For mutual systems the greatest number, 53.9, of toll and long distance messages per station per year was in California, and the least number, two-tenths of a message, in Oregon. The state for which the greatest number of mutual local messages was returned per station per day was Tennessee, the number being 6.7, while the least number, 2.3, is shown both for Colorado and Minnesota.

Relation between telephones, messages, and population.—Table 31 shows the estimated population, the number of telephones and messages, the number of messages per telephone and per capita, and the population per telephone in continental United States, by states and territories.

TABLE 31.—*All systems—telephones, messages, and population, by states and territories: 1902.*

STATE OR TERRITORY.	Number of stations or telephones of all kinds.	Number of messages or talks during year.	Estimated population.	Average population per telephone.	Average number of messages per capita.	Average number of messages or talks per telephone per year.
United States	2,315,297	5,070,554,553	78,576,436	34	65	2,190
Alabama	14,077	46,158,943	1,891,755	134	24	3,279
Arizona	3,259	5,072,727	129,869	40	39	1,557
Arkansas	16,892	36,716,883	1,347,934	80	27	2,174
California	106,574	178,284,400	1,537,837	14	116	1,673
Colorado	24,533	60,258,533	559,715	23	108	2,456
Connecticut	22,494	35,933,102	941,184	42	38	1,597
Delaware	4,293	8,962,892	187,461	44	48	2,088
Florida	8,216	18,906,002	554,104	67	34	2,301
Georgia	25,490	96,192,066	2,298,713	90	42	3,774
Idaho	3,862	6,451,762	176,416	46	37	1,671
Illinois	211,187	541,161,932	5,019,628	24	108	2,562
Indian Territory	5,331	8,337,959	434,436	81	19	1,564
Indiana	132,489	294,657,565	2,581,575	19	114	2,224
Iowa	120,017	193,054,738	2,301,427	19	84	1,609
Kansas	40,972	58,699,143	1,452,217	35	40	1,433
Kentucky	46,266	143,101,564	2,202,804	48	65	3,093
Louisiana	17,509	68,083,915	1,434,033	82	47	3,888
Maine	14,045	21,923,915	700,072	50	31	1,561
Maryland [1]	32,090	62,019,081	1,505,558	47	41	1,933
Massachusetts	96,512	183,115,320	2,917,796	30	63	1,897
Michigan	93,961	237,695,112	2,480,764	26	96	2,530
Minnesota	62,039	113,124,262	1,822,106	29	62	1,823
Mississippi	15,069	60,414,961	1,603,604	106	38	4,009
Missouri	93,371	242,309,227	3,187,031	34	76	2,595
Montana	5,421	11,352,976	266,120	49	43	2,094
Nebraska	36,153	73,227,030	1,087,526	30	67	2,025
Nevada	1,165	1,409,134	41,331	35	34	1,210
New Hampshire	9,949	16,987,012	418,602	42	41	1,707
New Jersey	48,980	56,171,223	1,969,821	40	29	1,147
New Mexico	2,481	4,297,920	202,316	81	21	1,732
New York	246,015	360,098,123	7,533,011	31	48	1,464
North Carolina	16,252	36,485,398	1,948,984	120	19	2,245
North Dakota	6,762	14,106,733	344,778	51	41	2,086
Ohio	222,767	558,707,801	4,252,372	19	131	2,508
Oklahoma	10,385	23,329,668	463,312	45	50	2,246
Oregon	21,172	35,777,238	429,380	20	83	1,690
Pennsylvania	186,572	493,617,718	6,505,887	35	76	2,646
South Carolina	10,467	23,893,914	1,378,150	132	17	2,283
South Dakota	10,305	17,919,604	429,808	42	42	1,739
Tennessee	36,060	128,274,719	2,070,354	57	62	3,557
Texas	64,410	167,079,014	3,203,303	50	52	2,594
Utah	5,734	11,755,130	289,519	50	41	2,050
Vermont	12,112	19,075,847	345,885	29	55	1,575
Virginia	24,130	65,494,626	1,899,440	79	34	2,714
Washington	31,447	64,623,982	558,055	18	116	2,055
West Virginia	22,376	41,605,891	998,004	45	42	1,859
Wisconsin	61,145	101,594,728	2,127,974	35	48	1,662
All other states [2]	12,489	23,033,120	544,465	44	42	1,844

[1] Includes District of Columbia.
[2] Includes Rhode Island and Wyoming.

Table 31 shows that on the average in the United States there were 34 persons to each telephone, that each person talked 65 times a year, and that each telephone was used 2,190 times; but the statistics for the different states indicate wide variations from these averages for the whole country.

Generally speaking, a liberal provision of telephonic facilities means a large number of calls or messages per capita and a low number per instrument. Moreover, it is generally true that the population per telephone is smallest, and consequently the telephone facilities are greatest, where the independent movement has had the widest development, and where the service is measured, while the number of calls per instrument is highest where the flat rates prevail.

The distribution of telephones, the use of each instrument, and the number of messages per capita do not depend solely upon density of population. Other factors, such as the kind of population, the prevailing nature of the industries, and the assiduity with which the telephonic habit has been cultivated by the managers of the companies supplying service, constitute potent agencies in varying the number of instruments installed and the use to which each is put. The most powerful influence is the tariff charged for telephone service. The effect of this influence is clearly reflected in the table. California was one of the earliest states to be served upon a measured service basis, and as this method of charging was vigorously pushed, the result was that this state had the largest number of telephones in proportion to its population, there being one telephone for every 14 inhabitants. Moreover, as a result of the low rates, the number of messages per capita was high in California, Ohio alone outranking it in this respect. Ohio exceeded California in population per telephone, with 19 inhabitants per instrument. It is not difficult to understand this condition when it is remembered that Ohio has been prominent in developing independent telephone service, and stands also among the first in the number of manufacturers of telephonic apparatus.

Telephones in urban centers.—During the past ten years there has been a very rapid and wide extension of telephone service in the rural districts, but, other things being equal, the industry has shown the greatest growth in the states having the largest population, and has reached its maximum development in the leading cities. In 1900 there were in continental United States 1,157 incorporated urban centers with 4,000 or more inhabitants. Of these, 1,002 were provided in 1902 with telephone systems of some description. In 137 of these towns the service was controlled by companies operating independently of the American Telephone and Telegraph Company, while in 414 the system was in the hands of that company, and in 451 telephone service was offered both by the American Telephone and Telegraph system and by an independent one.

Table 32 shows the statistics of population per telephone for the 14 principal cities.

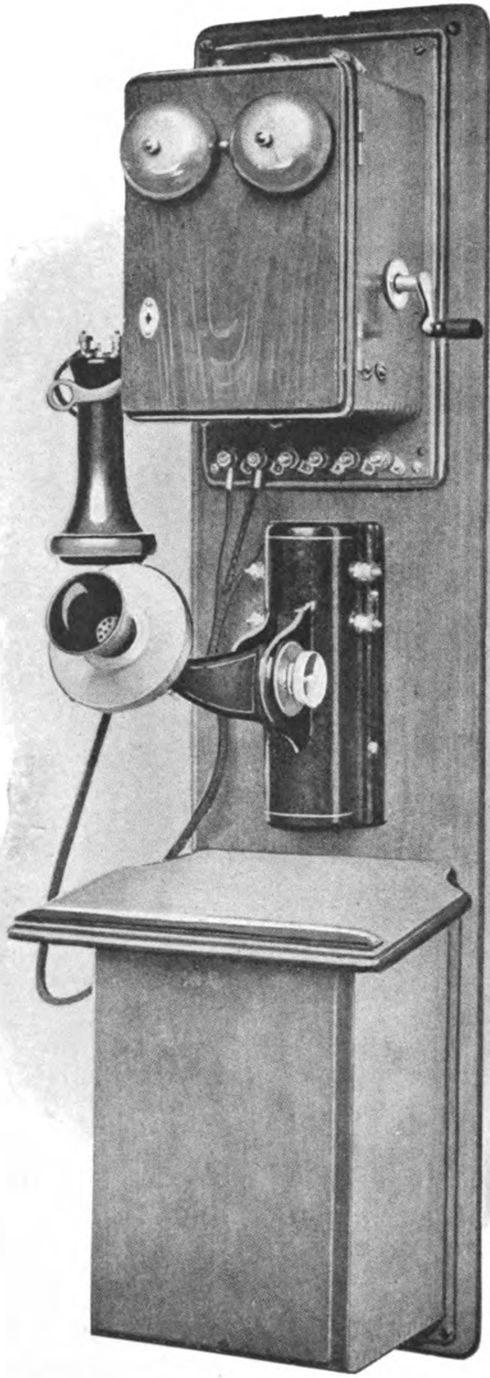


FIG. 1.—SUBSCRIBER SET, BRIDGING SYSTEM LINES, LOCAL BATTERY.

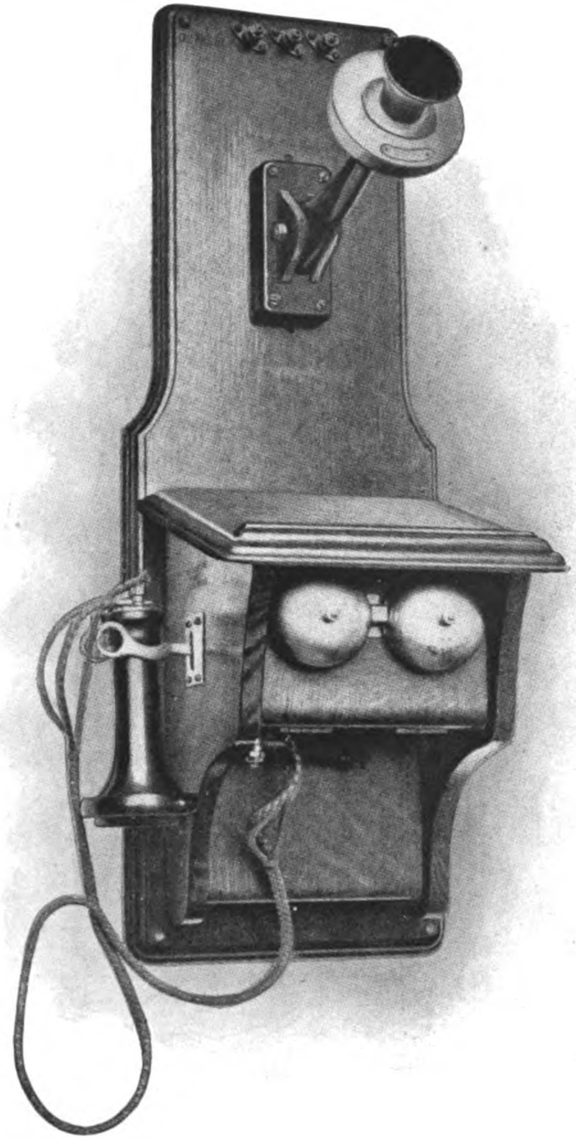


FIG. 2.—SUBSCRIBER SET, COMMON BATTERY OR CENTRAL ENERGY SYSTEM.

TABLE 32.—*Estimated population, number of telephones, and average population per telephone for the largest fourteen cities: 1902.*

CITY.	Estimated population.	Number of stations or telephones.	Average population per telephone.
New York	3,623,160	93,301	39
Chicago	1,815,445	60,948	30
Philadelphia	1,343,043	46,393	29
St. Louis	599,932	19,228	31
Boston	583,376	30,202	19
Baltimore	523,861	15,181	35
Cleveland	403,032	24,809	16
Buffalo	371,731	12,385	30
San Francisco	351,540	38,031	9
Cincinnati	329,590	13,627	24
Milwaukee	304,965	10,765	28
Detroit	301,670	12,536	24
New Orleans	296,118	7,158	41
Washington	283,551	8,051	35

Table 32 indicates that San Francisco, with 1 telephone to 9 persons, was the best telephoned city in the United States. Next to San Francisco was Cleveland, with 1 telephone for every 16 persons. These abundant facilities are accounted for by the fact that there are in Cleveland 2 large exchanges—one operated by the Cleveland Telephone Company (Bell) and the other, an independent exchange, by the Cuyahoga Telephone Company. The third city, according to population per telephone, was Boston, with 1 telephone to every 19 inhabitants. It is noteworthy that the large cities—such as Philadelphia, Chicago, and New York—are very near the foot of this list, having, respectively, 1 telephone to 29, 30, and 39 inhabitants. This is due to the combined operation of three causes: The proportion of the immigrant population of a class that does not use telephone facilities is much greater in the very large cities than in the smaller ones; telephone rates are considerably higher in these large cities than in the smaller ones, and there has been no competition in the two principal cities. The lowest average per capita among these cities was shown for New Orleans, where there was 1 telephone to every 41 inhabitants.

The conditions that environ the telephone system of a large city are entirely different from those existing in a small town or in rural districts, and consequently the traffic in such places is totally dissimilar in volume, rate, and time of activity. Accepting a population of 4,000 inhabitants as the line of demarcation between the large and the small places, or the urban and the rural population, Table 33 is a summary of the statistics for the commercial telephone systems having their exchanges or centrals in urban and rural districts.

TABLE 33.—*Summary—urban and rural commercial systems: 1902.*

	Total.	Urban.	Rural.
Number of systems	3,157	530	2,627
Miles of wire	4,779,571	4,361,013	418,558
Number of stations or telephones of all kinds	2,225,981	1,823,956	402,025
Number of public exchanges	9,419	5,480	3,939
Number of messages or talks during year	4,971,413,070	4,351,724,325	619,688,745
Salaried officials, clerks, etc.:			
Number	13,958	12,393	1,565
Salaries	$9,871,596	$9,263,356	$608,240
Wage-earners:			
Average number	63,630	56,262	7,368
Wages	$26,206,065	$24,343,526	$1,862,539
Total revenue	$86,522,211	$79,963,998	$6,558,213
Total expenses	$79,864,419	$75,372,210	$4,492,209
Net surplus	$6,657,792	$4,591,788	$2,066,004

Table 33 shows that the number of systems having their principal central, or exchange, in municipalities of less than 4,000 inhabitants was about 5 times the number having their exchanges, or centrals, in municipalities of greater population; and that the systems whose headquarters were in the larger places averaged more than 22 times the number of telephones per system and handled over 34 times the traffic of the smaller places.

Rates.—The first use made of the telephone was on private lines connecting two individual stations, the lines not going through an exchange. For this purpose the original patentees furnished the instruments and charged a rental for their use. As soon, however, as the telephone exchange was developed the element of labor in connecting different subscribers' lines at the exchange became a factor in the business. The exchange proprietor, either an individual or a corporation, was then obliged to build and keep in repair the lines, the switchboards, and the subscribers' instruments, and to provide facilities for an increase of business; so that although the old term of "rental" remained in use after the establishment of the exchange, the charge made to telephone subscribers became a charge for telephone service and not a charge for rental of instruments.

As the exchanges grew the number of subscribers increased, and with the increase in the number of persons who could be reached by a telephone the value of the telephone service to each subscriber became greater, and the result was a greater use of the telephone, the increase in the use being at a rate greater than the mere increase in numbers would indicate. The greater demand on the service naturally increased the cost of supplying telephone service. With the increased number of subscribers the area within which the subscribers were located became larger, and longer lines were necessary. There were corresponding increases in the investment for each station, in the amount of work required in making the connections between subscribers' lines, and in the expenses of repairs.

It was soon discovered that the rates fixed by the first exchanges, which were sufficient when based upon a small number of individual telephones connected to an exchange, were too low to meet the expenses of the operation of the larger exchange and give a fair return upon the capital. The problem of rates then became one of arranging the charges for service so that all could use the telephone.

The first differentiation in rates was between business places and residences, it being plainly evident that the latter used the telephone to a much smaller extent than the former. This division between business and residence rates continues throughout the entire country, and with but few exceptions is found in every telephone exchange.

The division into these two classes was not, however, sufficient to cover the necessary gradations in charges if all the people were to be connected by means of the telephone system, and party line devices, enabling the placing of more than one telephone upon each circuit, were put in operation. Under the system of party line rates the rate is graded by the number of subscribers placed upon one circuit, and here again the distinction between business and residence is retained, each group having its own party line rates.

The system of allowing the subscriber to use the telephone as freely as he chose upon the payment of a fixed sum monthly or quarterly, was in its turn supplemented by the so-called measured rate, under which the subscriber pays for the actual use made of the service. Under this system a minimum charge is made, and for this payment a fixed number of messages are furnished, messages in excess of those contracted for being paid for at a specified rate per message.

This system naturally reaches its highest development in the larger cities and allows the gradation of rates to be carried on to such an extent that everyone can find a rate suited to his own needs. A modification of this measured service rate is in use in Great Britain, where the post office telephones are charged for on a combination rate, a fixed charge sufficient to meet the interest and the depreciation of the plant being collected annually, and each message being charged for at a rate that is supposed to be sufficient to cover all expenses of operation.

The measured rate system is undoubtedly the logical one, as the subscriber pays exactly in proportion to his use of the telephone, and instead of the large user securing service at a rate much below the cost of the service and the small user paying much more than the cost, each user pays his proper share, the average return to the company giving a return on the whole investment. It has not been found practicable to introduce this measured rate system in small places, and although its use is increasing, it is at present confined to the larger cities.

Charges for the use of lines connecting distant points are usually based upon the time consumed during the conversation. This is the logical method of charge, because of the large investment necessary to build such lines and the consequent necessity of keeping the circuits as fully occupied as possible. Although on many of the smaller and less important lines there is no limitation as to the duration of a message, on lines where business is abundant the initial period is fixed and an extra charge is made for each minute of overtime. There is a great variation in the length of the initial period, but it is usually fixed at either five or three minutes. In some parts of the country and between towns closely connected in a business way rates are sometimes made for shorter initial periods, the periods being in some cases even as low as a quarter of a minute To further utilize the investment in long distance lines and stimulate their use it is customary to give night service at reduced rates.

The rates are also governed by the character of the service given, whether on individual lines or on party lines, by metallic circuits or grounded circuits, by underground circuits and cables, which represent a large outlay, or by other circuits.

The cost of a service which is given to a large number of subscribers in any city over a large area, and which has sufficient equipment to supply the demands of all the users during the time of the maximum use, is necessarily much higher than the cost of a service that is given by a small exchange which has a compact territory and which at no time has any excessive demand upon its facilities. Telephone rates, therefore, are higher in large than in small cities. The rates, moreover, are low among the mutual and cooperative companies, with but few subscribers, since for such companies the members themselves do a large part toward the operation and maintenance of the plants. No attempt was made to tabulate the rates charged for telephone service, since they vary greatly as a result of the conditions covered by the numerous classes of service given by the companies.

All these variations are found in all parts of the country, and the description [1] of the evolution of the telephone rates of New York city, where the logical plan of charging each subscriber as nearly as possible the cost of his particular class of service has been carried to the highest development, gives a very good idea of the problem involved in the question of rates for telephone service.

Traffic per subscriber and instrument.—While the preceding tables convey an idea of the bulk of telephone traffic, it requires a further analysis to indicate the average amount of business transacted from each instrument and by each subscriber. This is shown in Table 34 for the commercial and mutual systems in continental United States and for the outlying districts.

TABLE 34.—*Messages per subscriber and per telephone: 1902.*

KIND OF SYSTEM.	AVERAGE NUMBER OF MESSAGES.					
	Per subscriber.			Per telephone.		
	Total.	Local.	Long distance and toll.	Total.	Local.	Long distance and toll.
Continental United States	2,327	2,272	55	2,190	2,138	52
Commercial	2,378	2,321	57	2,233	2,179	54
Mutual	1,119	1,112	8	1,110	1,102	8
Outlying districts	1,350			1,344		

A comparison between the traffic handled by the American Telephone and Telegraph Company and the independent systems is shown in Table 35.

[1] See Chapter X.

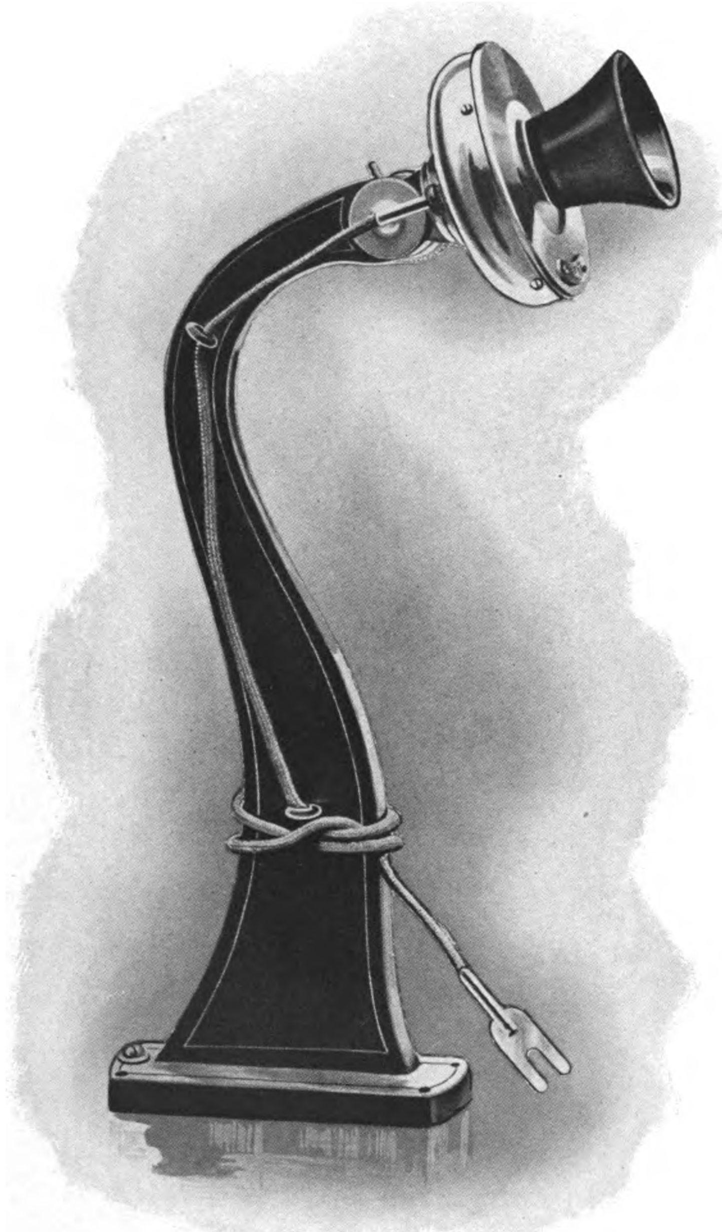


FIG. 1.—CABINET SET TRANSMITTER.

FIG. 2.—BIPOLAR RECEIVER.

TABLE 35.—*Traffic comparison, Bell and independent systems: 1902.*

	Total.	BELL.		INDEPENDENT.	
		Number.	Average per system and subscriber.	Number.	Average per system and subscriber.
Number of systems	4,151	44	....	4,107	....
Number of subscribers	2,178,366	1,222,327	27,780	956,039	233
Number of stations or telephones	2,315,297	1,317,178	29,935	998,119	243
Messages or talks, total number	5,070,554,553	3,074,530,060	2,515	1,996,024,493	2,088
Local exchange	4,949,849,709	2,998,344,933	2,453	1,951,504,776	2,041
Long distance and toll	120,704,844	76,185,127	62	44,519,717	47

As shown by Table 35, the Bell companies operated 123 times as many telephones per system as the independent companies; the total local business of the Bell companies was 53.6 per cent greater than the corresponding independent traffic, while the calling rate per subscriber was 20.2 per cent larger; and the toll and long distance work on the Bell lines was 71.1 per cent greater than that over the independent ones, while the toll and long distance calls per subscriber were 31.9 per cent more.

The difference in the traffic rate per subscriber is probably to be explained by the fact that a large proportion of the Bell service in the United States is based upon some measured rate plan, either involving the use of telephone registers or pay stations, or requiring the operator to make a ticket for each call. The independent companies had rarely adopted measured service up to the time when their reports were made.

Relation of traffic to earnings and expenses.—The relation of traffic to earnings and expenses is an important one, both from the standpoint of the telephone company and from that of the subscriber. When the cost to the subscriber is based upon some form of measured service, the volume of business is a more or less direct measure of the revenue of the company and of its cost of operation. The operation of any form of metered service tends to reduce the amount of traffic; for if subscribers are charged by the message, they invariably economize as much as practicable. If the charge for the traffic is at a flat rate, the company's revenue depends upon the number of instruments installed and not upon the volume of traffic, while the expenses are measured more nearly by the number of messages transmitted. With a flat rate service there is no tendency toward economy on the part of the subscriber, for, knowing that his telephone charges are represented by a fixed annual sum, he and his friends use the instrument liberally.

Table 36 shows the average revenue and operating expense per telephone and message, by states and territories.

TABLE 36.—*All systems—average revenue and operating expense per telephone and per message, by states and territories: 1902.*

STATE OR TERRITORY.	Average number of messages per telephone per year.	AVERAGE GROSS REVENUE.		AVERAGE OPERATING EXPENSE.	
		Per telephone (dollars).	Per message (cents).	Per telephone (dollars).	Per message (cents).
United States	2,190	37.50	1.712	24.56	1.121
Alabama	3,279	37.57	1.146	22.37	0.682
Arizona	1,557	35.13	2.256	21.44	1.377
Arkansas	2,174	33.45	1.539	21.80	1.003
California	1,673	38.39	2.295	30.02	1.795
Colorado	2,456	46.36	1.887	31.23	1.271
Connecticut	1,597	59.05	3.696	39.45	2.469
Delaware	2,088	44.22	2.118	36.66	1.756
Florida	2,301	25.82	1.122	16.65	0.723
Georgia	3,774	33.86	0.897	21.26	0.563
Idaho	1,671	46.16	2.763	34.79	2.082
Illinois	2,562	34.61	1.351	23.73	0.926
Indian Territory	1,564	30.79	1.969	17.55	1.122
Indiana	2,224	21.26	0.956	13.54	0.609
Iowa	1,609	16.35	1.016	10.53	0.654
Kansas	1,433	21.42	1.495	12.76	0.891
Kentucky	3,093	29.77	0.963	19.72	0.638
Louisiana	3,888	45.88	1.180	23.69	0.609
Maine	1,561	42.52	2.724	29.12	1.866
Maryland[1]	1,933	47.28	2.446	34.46	1.783
Massachusetts	1,897	63.49	3.346	43.58	2.297
Michigan	2,530	26.01	1.028	18.31	0.724
Minnesota	1,823	30.30	1.662	18.30	1.004
Mississippi	4,009	32.95	0.822	20.10	0.501
Missouri	2,595	31.81	1.226	19.14	0.737
Montana	2,094	56.26	2.686	39.43	1.883
Nebraska	2,025	30.63	1.512	22.10	1.091
Nevada	1,210	30.05	2.484	15.85	1.310
New Hampshire	1,707	39.87	2.335	30.66	1.796
New Jersey	1,147	55.91	4.876	39.55	3.449
New Mexico	1,732	21.94	1.267	12.98	0.749
New York	1,464	66.47	4.541	39.75	2.718
North Carolina	2,245	21.32	0.950	14.93	0.665
North Dakota	2,086	34.81	1.669	20.20	0.968
Ohio	2,508	27.80	1.108	17.06	0.680
Oklahoma	2,246	25.83	1.150	16.37	0.729
Oregon	1,690	31.13	1.842	21.34	1.263
Pennsylvania	2,646	43.33	1.638	28.91	1.093
South Carolina	2,283	27.23	1.193	17.86	0.783
South Dakota	1,739	27.86	1.602	15.84	0.911
Tennessee	3,557	34.73	0.976	24.47	0.688
Texas	2,594	38.60	1.488	24.60	0.949
Utah	2,050	51.26	2.501	37.59	1.833
Vermont	1,575	26.62	1.690	19.33	1.227
Virginia	2,714	25.25	0.930	16.73	0.616
Washington	2,055	31.48	1.532	24.77	1.205
West Virginia	1,859	22.69	1.220	15.21	0.818
Wisconsin	1,662	26.16	1.575	16.17	0.973
All other states[2]	1,844	69.31	3.758	43.46	2.356

[1] Includes District of Columbia.
[2] Includes Rhode Island and Wyoming.

According to Table 36 the average revenue per telephone amounted to $37.50. The highest rate was secured in New York and was $66.47, or 77.3 per cent more than the average. The lowest revenue was reported for Iowa and was only $16.35, or 43.6 per cent of the average. The greatest revenue per message—4.88 cents—was shown for New Jersey, New York ranking second, with 4.54 cents. The least revenue per message was reported for Mississippi and was a little more than four-fifths of a cent. Operating expenses per telephone were highest in Massachusetts, where they reached $43.58, and lowest in Iowa, where they were $10.53. The lowest operating cost per message was shown for Mississippi, where the average was one-half a cent, while the highest operating cost, 3.45 cents, was found in New Jersey.

The high rates per telephone in New York state are explained by the fact that this state contains the city that is at the same time the largest city of the country and the one that does the greatest amount of telephonic business. As the expense of operation increases faster than the population, it is necessary to arrange the tariff in recognition of the fact. But New York city is served upon measured rates, hence the traffic rate per subscriber is low, and the operating cost per message is less than in places, such as some of those in New Jersey, where the flat rate is more prevalent.

It is significant that the people in the United States received telephone service during 1902 at an average cost of 1.71 cents per message transmitted, and that the average revenue above operating expenses amounted to fifty-nine one-hundredths of a cent per message.

Other factors of traffic.—The preceding tables have been occupied chiefly with the total traffic reported for the various civil and geographic divisions of continental United States. But it is desirable to consider also the variation in the number of messages which subscribers offer, the manner in which and the time when the business is delivered to the central office, and the ability of the operators and apparatus to handle it. As the reports do not permit such an analysis to be made for every system, diagrams have been prepared containing a digest of statistics for about two thousand operators so selected that they are fairly representative. These are called "load diagrams," because they show the varying weight or load of traffic.

If every person wished to talk an equal number of times per day to everyone else, the traffic would be proportional to the size of the community and would depend on the number of combinations, taken two at a time, that could be made for the total number of inhabitants. Experience shows that this does not happen, because of what is termed "the acquaintance factor." In every community each individual is acquainted with and transacts business among a certain limited group; and while such circles of acquaintance overlap and the business increases more rapidly than is indicated by a simple arithmetical ratio to the population, it does not increase quite as fast as the square of the population.

Different communities vary in the amount of business they offer. In general, small towns of 10,000 or under are likely to show from 4 to 6 calls per subscriber per day. The business portions of medium-sized and large cities vary from 10 to 15 calls, the residence portions from 2 to 4 calls, while party lines average from 3 to 4 calls.

The operations necessary for each message consume a certain amount of time; consequently the number of operators and the size of switchboard needed to handle a given amount of business will depend on the speed that the operator can attain, the efficiency of the switchboard, and the promptness with which the subscribers cooperate. The speed attained depends upon the capability of the operator and the amount of training received, as well as upon the nature of the apparatus. Upon magneto switchboards installed in small country towns from five to ten seconds elapse between the signal of the subscriber and the answer of the operator, while from ten to thirty seconds are often consumed in disconnecting subscribers' lines after service. With automatic lamp signal switchboards the operation is much expedited. Many systems strive to secure what is called "three-second service;" that is to say, on the average only three seconds elapse between the removal of the receiver and the answer of the operator, while disconnection is usually accomplished in from three to five seconds. It is only in the best managed and most highly efficient systems that this speed is uniformly secured. Taking the average of all systems, five-second service is more common. The service over trunk lines inevitably consumes more time.

In the business districts of urban centers, messages are handled most speedily, because business men are trained to prompt and quick action, and usually have a fair idea of the inconvenience to which others are subjected by a delay in replying, while residents in small towns and villages often display indifference to the prompt answering of a telephone call.

In order that the service shall be good it is necessary that sufficient operating force be provided to transact the business offered during the busy hours at such speed as shall be satisfactory to subscribers. An examination of the diagrams will show that approximately 12 per cent of the business is offered during the busiest hour of the day.

Traffic records.—It is customary for central offices to keep more or less careful record of traffic. The common method is to make a monthly count of the number of originating calls and trunk messages during a given twenty-four hours. Usually each operator is provided with a wooden peg about the size of the ordinary plug, and is instructed to use the set of 100 multiple jacks nearest in front of her. Commencing at midnight of the predetermined twenty-four hours, all operators insert these pegs in the zero jacks of the banks, and then each operator moves the peg along one jack for every call that is received. At the end of each hour a clerk makes a memorandum of the number of the jack in which each peg stands and removes the peg to the zero jack, thus making a record of the number of calls that each operator has answered. Such a traffic enumeration is termed a peg count.

For toll line work, or measured service, where tickets are made for each call, the traffic record becomes automatic. If lines are supplied with a message meter located in the exchange, an hourly inspection of each meter is all that is required.

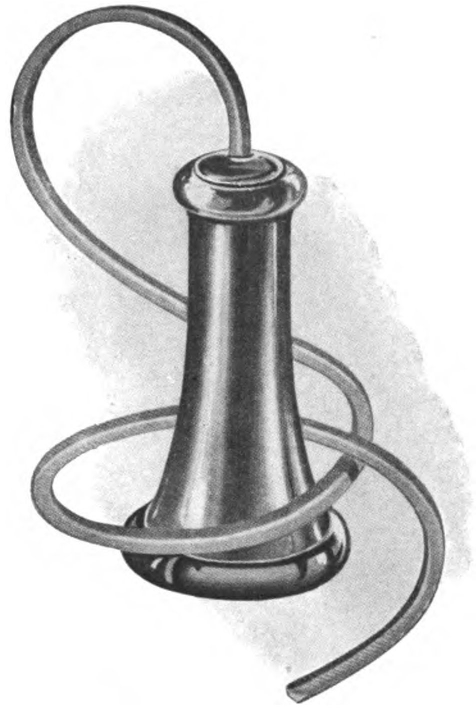


FIG. 1.—TELEPHONE RECEIVER.

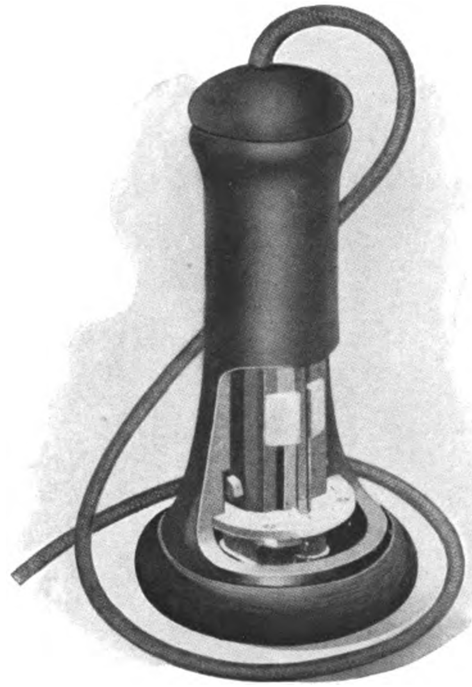


FIG. 2.—SECTION OF RECEIVER.

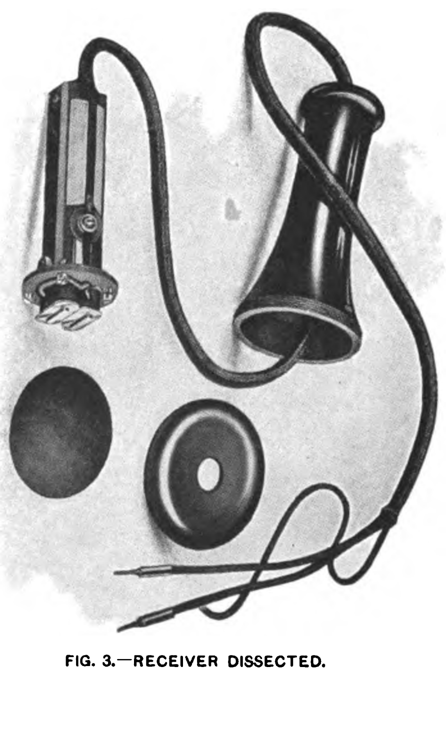


FIG. 3.—RECEIVER DISSECTED.

FIG. 4.—DESK SET, RECEIVER AND TRANSMITTER.

DIAGRAM 1.—*Telephone calls by hours, business center, residence district, and outskirts of a large city: 1902.*

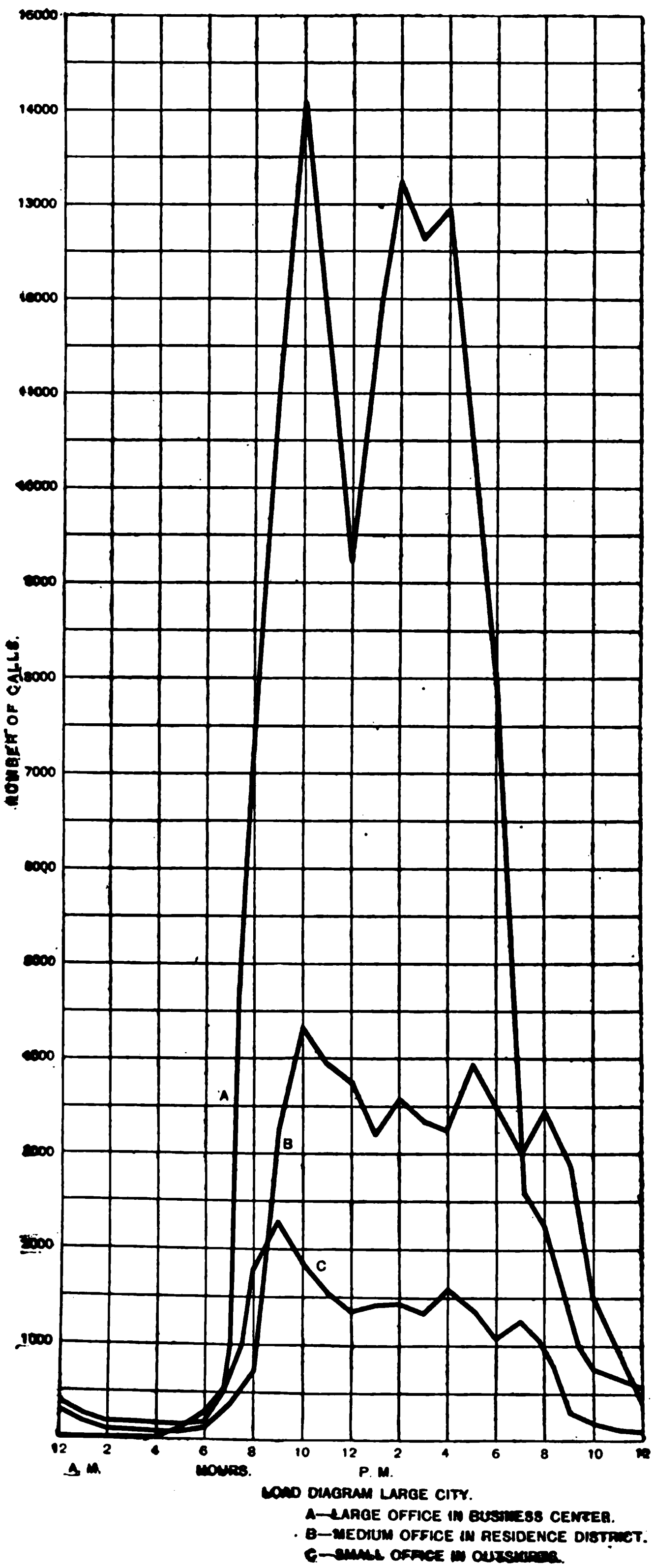
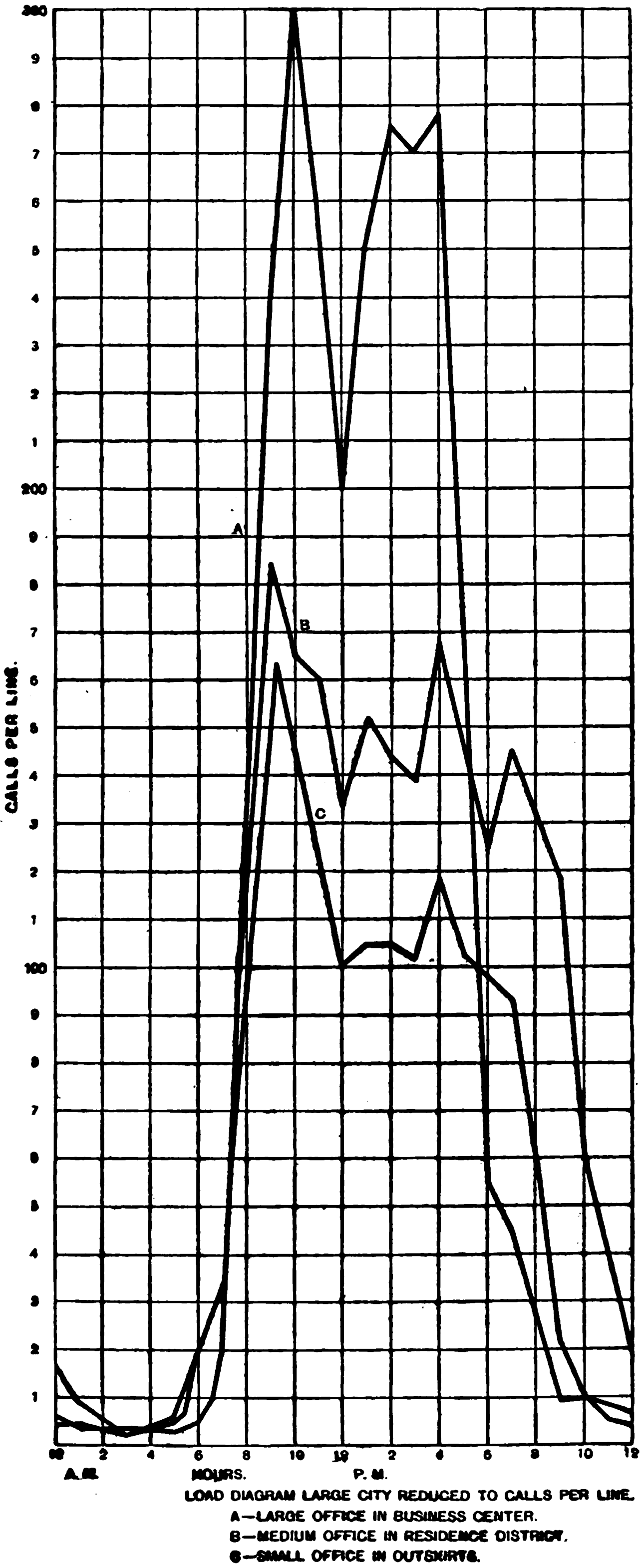
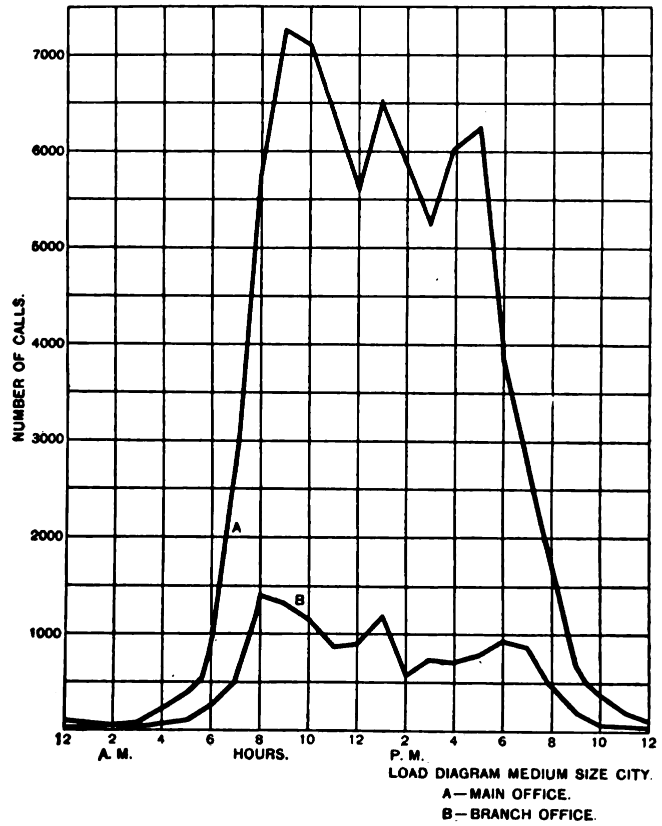


DIAGRAM 2.—*Telephone calls per line in the three districts of a large city shown by hours in Diagram 1: 1902.*



To convey quickly and saliently to the eye the statistics gathered in a traffic record it is convenient to plot them, showing upon the horizontal scale the hours of the day and upon the vertical scale the number of calls received. Diagram 1 presents in this way the record for three exchanges in a large city. Three curves are shown. Curve A is the load line of a large

Diagram 3.—*Telephone calls by hours, main and branch offices, in city of medium size: 1902.*



exchange of from four to five thousand subscribers; curve B, that of a medium-sized exchange of from twenty-five hundred to three thousand subscribers in a residence district; and curve C, that of a small exchange of from eight hundred to a thousand subscribers in the outskirts. Diagram 3 is the traffic record of an exchange in a medium-sized city, curve A relating to the main office of the business district and curve B, to a branch office. Diagram 4 is for a manufacturing city with a population of about one hundred thousand. Diagram 5 is the load line of a village of about two thousand inhabitants.

There is a general resemblance between the diagrams, which show that the telephonic load lines contain one high peak in the morning and one or more in the afternoon. In the large city the peak of the load occurs later in the day than in the city of medium size, and the falling off of traffic during the noon hour is more marked. In the manufacturing city two peaks occur, one relatively early and the other relatively late in the day, while in the small village there are three distinct peaks, one in the morning and two in the afternoon, the one at 3 p. m. being the highest.

It is instructive to transform the diagrams which show total originating calls in such a manner as to show the calls per line. In Diagram 2 this transformation is performed for Diagram 1.

Diagram 4.—*Telephone calls by hours in a manufacturing city having a population of about 100,000: 1902.*

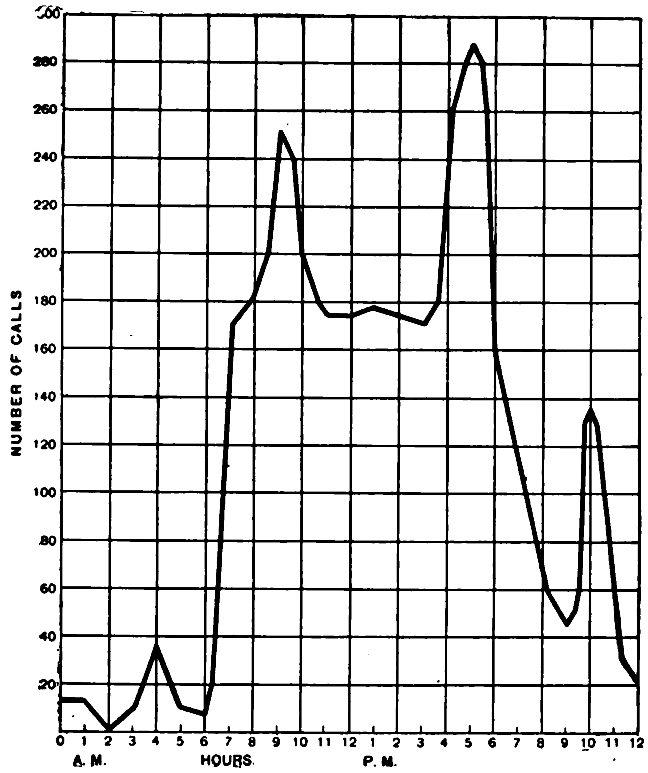
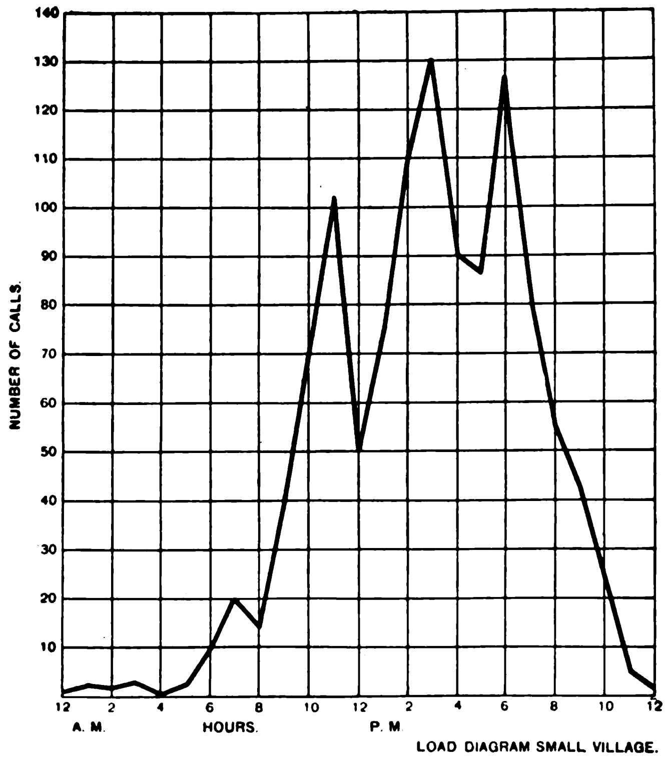


Diagram 5.—*Telephone calls by hours in a village having a population of about 2,000: 1902.*



The salient change is the difference in the relative heights of the curves in the main office and the subsidiary offices, for, when the loads are plotted in calls per line, there is a far less proportionate difference than that which seems to be indicated by the total load lines.

CHAPTER VI.

APPARATUS OF THE SUBSTATION.

Physical equipment.—The preceding statistics show that the number of messages handled by the telephone systems of continental United States in 1902 was estimated at 5,070,554,553. To care for this enormous interchange of conversation a considerable equipment of apparatus was necessary.

Table 37 summarizes the physical equipment for all systems.

TABLE 37.—*Summary—all systems, physical equipment: 1902.*

Number of systems	4,151
Switchboards, total number	10,896
Manual:	
Common battery	837
Magneto	10,005
Automatic	54
Total capacity of switchboards	2,447,403
Engines, horsepower	2,750.5
Dynamos, horsepower	5,459.1
Electric motors, horsepower	4,209.8
Auxiliary cross-connection boards, etc	9,255
Magneto generators, ringers, etc., in exchanges	14,931
Batteries:	
Primary, number of cells	110,648
Storage, number of cells	19,001
Stations or telephones, total number	2,315,297
Total miles of wire	4,850,486
Underground construction:	
Miles of duct	16,474.9
Miles of cable	7,290.6
Miles of wire	1,690,502
Overhead construction:	
Miles of single wire	2,369,914
Miles of cable	8,104.5
Circuit miles of wire in cable	780,530
Submarine:	
Miles of cable	262.6
Circuit miles of wire in cable	9,540

From a technical aspect it is convenient to divide the apparatus of every telephone system into three parts:

1. The substation, including the transmitter, receiver, and signaling appliances on the premises of the subscriber.

2. The wire plant, embracing the electrical conductors which connect the substations and the central office.

3. The central office, containing the apparatus necessary to enable different lines to be rapidly connected.

In the case of interconnecting systems and independent farmer or rural lines there is no central office, because each station becomes its own central office, the subscriber performing for himself the functions of the operator in securing a connection with the desired correspondent.

The collection of appliances placed on the premises of a subscriber in order to provide telephone service is variously called a substation or substation outfit, an instrument, a telephone, or a box.

Statistics of substations.—The statistical tables have conveyed a general idea of the number of substations in continental United States in 1902, Table 2 showing 2,315,297 stations, serving 2,178,366 subscribers, an average of 1.063 instruments per subscriber. There were more instruments than subscribers because, in many instances, one subscriber had sufficient business to require the installation of more than one substation.

Table 4 gives the number of telephones and shows their distribution among the commercial and mutual systems and the independent rural lines.

From the standpoint of operating companies Table 6 shows the number of stations served by the Bell systems and by the independent systems. The number of stations reported by the Bell organizations was 1,317,178, or 56.9 per cent of the total; while the number reported by other systems was 998,119, or 43.1 per cent.

Table 7 shows the distribution of stations by geographic divisions. The North Central division contained the largest number of telephones, the proportion being 47.1 per cent of the whole. The North Atlantic division ranked second, with 28 per cent. When telephonic facilities are considered on the basis of population per telephone, the Western division stood at the head, with a population of 21 per instrument; while the South Atlantic division was at the foot of the list, with 75 inhabitants per instrument.

The number of instruments for both the commercial and mutual systems are distributed by geographic divisions in Tables 9 and 11. For each of these systems the North Central division contained the greatest number of instruments, the proportions being 45.6 per cent for the commercial systems and 86.2 per cent for the mutual. The latter percentage shows that this is the area in which there has been the greatest development of mutual systems.

Tables 43, 46, 48, and 50 show the distribution of substations by states and territories. Table 50 shows that Iowa, Illinois, and Missouri led the list for mutual systems, showing, respectively, 21,355, 16,831, and 10,962 substations. These three states contained 55 per cent of all mutual stations.

Rural substations.—The country districts are served by independent rural lines, by the mutual systems, all of which may be accepted as serving in rural districts exclusively, and by rural lines owned and operated by commercial systems with whose exchanges the lines are connected. Commercial systems having their principal exchange in larger cities often serve the smaller places, but it is the exception to find an exchange in a small place serving a large city.

It is impossible to make an exact segregation of the statistics so as to show the amount of wire and the number of telephones devoted primarily to telephone work in the country as distinct from the urban districts. The number of rural lines of each of the three classes, their wire mileage, and the number of their telephones are, however, indicated approximately by states and territories in Table 38.

Table 38.—NUMBER OF RURAL LINES, CLASSIFIED AS COMMERCIAL, MUTUAL, AND INDEPENDENT RURAL, WITH THE WIRE MILEAGE AND THE NUMBER OF TELEPHONES, BY STATES AND TERRITORIES: 1902.

STATE OR TERRITORY.	NUMBER OF LINES.				MILES OF WIRE.				NUMBER OF TELEPHONES.			
	Total.	Commercial.	Mutual.[1]	Independent rural.	Total.	Commercial.	Mutual.	Independent rural.	Total.	Commercial.	Mutual.	Independent rural.
United States	21,577	15,598	994	4,985	259,306	138,426	70,915	49,965	266,968	121,905	89,316	55,747
Alabama	33	11	4	18	671	263	101	307	291	89	109	93
Arizona	13	11	1	1	194	146	30	18	205	128	72	5
Arkansas	53	48	...	5	357	274	...	83	159	123	...	36
California	69	61	6	2	1,407	439	923	45	854	385	393	76
Colorado	40	37	3	...	331	261	70	...	254	226	28	...
Connecticut	7	6	1	...	30	20	10	...	78	33	45	...
Florida	57	35	2	20	605	224	45	336	235	138	44	53
Georgia	73	41	6	26	1,411	622	177	612	648	267	110	271
Idaho	7	3	1	3	145	10	83	52	93	9	60	24
Illinois	3,883	2,925	138	820	47,463	26,516	13,308	7,639	49,440	22,788	16,831	9,821
Indian Territory	10	4	...	6	105	20	...	85	24	8	...	16
Indiana	3,255	2,215	105	935	28,380	15,602	9,220	3,558	28,190	14,428	9,690	4,072
Iowa	2,958	1,672	170	1,116	40,251	14,516	13,261	12,474	58,364	18,626	21,355	18,383
Kansas	365	342	11	12	3,347	2,382	650	315	3,509	2,633	655	221
Kentucky	140	34	35	71	2,675	471	1,308	896	2,197	443	1,071	683
Louisiana	32	12	1	19	428	199	9	220	132	91	7	34
Maine	65	59	4	2	3,869	3,776	77	16	3,909	3,778	106	25
Maryland	16	12	4	...	162	81	81	...	94	42	52	...
Massachusetts	11	11	...	...	148	148	...	...	197	197	...	...
Michigan	981	868	33	80	10,971	7,293	2,335	1,343	9,808	4,984	3,370	1,454
Minnesota	555	454	31	70	8,310	5,593	1,799	918	7,603	4,282	2,168	1,153
Mississippi	95	61	3	31	1,273	655	70	548	641	332	38	271
Missouri	1,712	735	90	887	25,094	6,746	8,564	9,784	26,510	5,764	10,962	9,784
Montana	13	...	2	11	212	...	120	92	61	...	31	30
Nebraska	612	556	32	24	8,855	6,625	1,656	574	7,248	4,991	1,644	613
Nevada	2	...	2	...	174	...	174	...	22	...	22	...
New Hampshire	42	42	...	...	999	999	...	...	904	904	...	...
New Mexico	12	9	...	3	174	91	...	83	78	49	...	29
New York	481	320	88	73	4,692	2,382	1,593	717	6,578	2,404	2,849	1,325
North Carolina	279	144	12	123	3,492	1,419	633	1,440	1,833	668	381	784
North Dakota	61	58	3	...	652	612	40	...	669	598	71	...
Ohio	3,056	2,872	49	135	22,757	17,983	3,516	1,258	24,236	16,884	6,036	1,316
Oklahoma	24	23	1	...	295	245	50	...	246	196	50	...
Oregon	31	22	5	4	1,008	535	435	38	842	268	556	18
Pennsylvania	325	297	20	8	4,967	3,585	1,199	183	3,438	1,793	1,483	162
Rhode Island	3	3	...	...	39	39	...	...	35	35	...	...
South Carolina	254	155	6	93	2,494	1,337	333	824	1,020	550	184	286
South Dakota	34	21	7	6	712	395	225	92	580	239	259	82
Tennessee	149	96	13	40	3,211	1,083	1,683	445	1,962	577	1,053	332
Texas	422	345	12	65	4,874	3,354	478	1,042	2,177	1,687	164	326
Vermont	217	209	6	2	3,325	3,203	106	16	3,567	3,355	173	39
Virginia	409	232	22	155	7,615	3,391	2,218	2,006	5,599	1,626	2,341	1,632
Washington	14	14	...	...	124	124	...	...	117	117	...	...
West Virginia	107	55	21	31	2,045	555	1,062	428	1,839	531	883	425
Wisconsin	597	468	43	86	8,868	4,212	3,263	1,393	10,449	4,639	3,963	1,847
Wyoming	3	...	1	2	95	...	10	85	33	...	7	26

[1] Systems.

If all the places with a population of less than 4,000 be considered as rural districts, it will be necessary to add to the totals shown in Table 38 a considerable proportion of the wire and telephones reported by the commercial companies having their principal exchanges, or centrals, located in such places. As shown in Table 33, of the 3,157 commercial systems reported, 2,627, or 83.2 per cent, had their principal exchanges in places of less than 4,000 inhabitants, and operated 418,558 miles of wire and 402,025 telephones. While the combination of these totals with those shown in Table 38, giving 677,864 miles of wire and 668,993 telephones, produces some duplication, these figures may be accepted as an approximation of the rural telephone service.

The rural substations, as shown in Table 38, aggregated 266,968, of which the commercial systems reported 45.7 per cent, the mutual systems, 33.4 per cent, and the independent rural lines, 20.9 per cent.

Table 39 contains statistics for the five states in which there were the greatest number of rural lines.

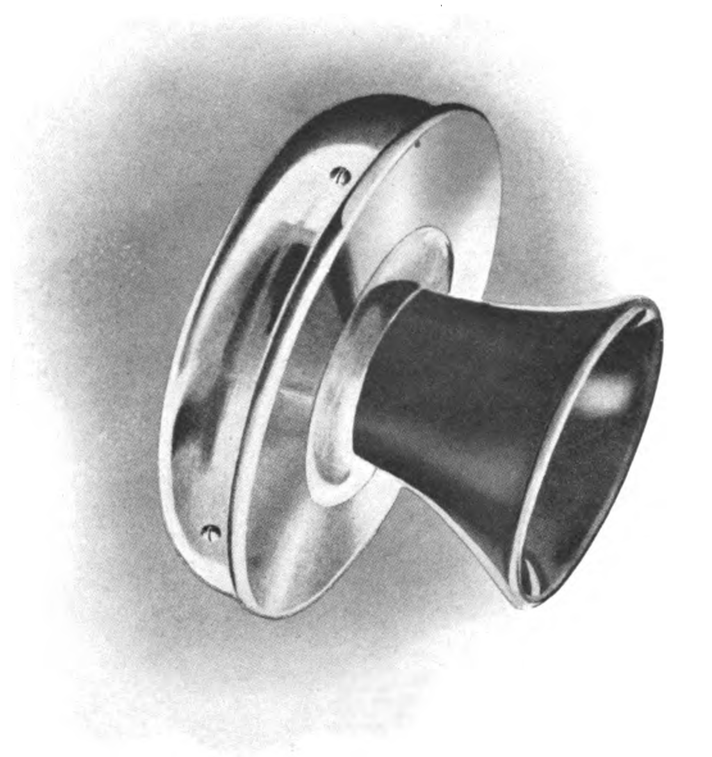


FIG. 1.—TRANSMITTER HEAD.

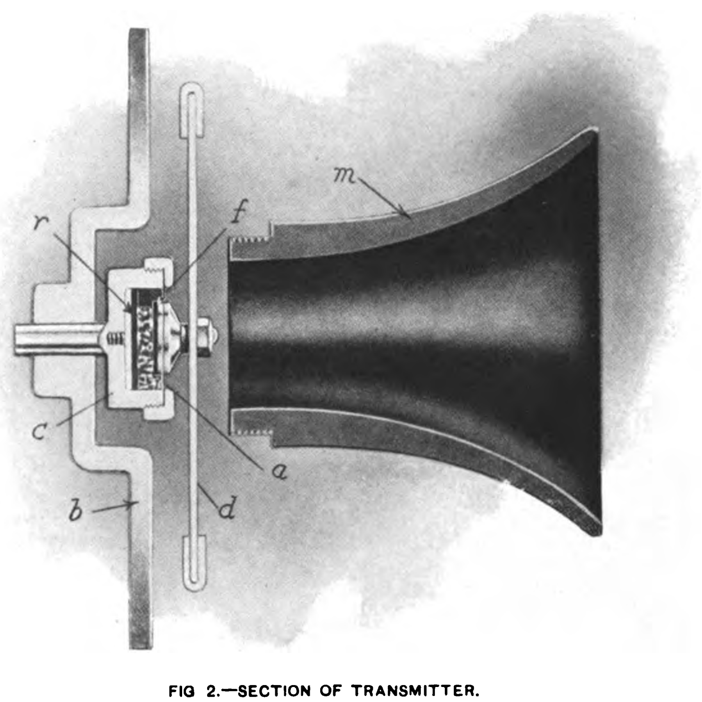


FIG 2.—SECTION OF TRANSMITTER.

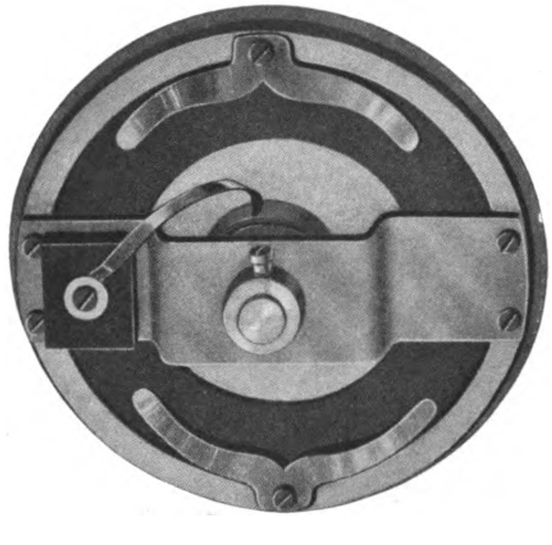


FIG. 3.—REAR VIEW OF ASSEMBLED TRANSMITTER. CASE REMOVED.

TABLE 39.—*Number of rural lines, with the wire mileage and the number of telephones, for the five leading states: 1902.*

STATE.	LINES.		MILES OF WIRE.		TELEPHONES.	
	Number.	Rank.	Number.	Rank.	Number.	Rank.
Illinois	3,883	1	47,463	1	49,440	2
Indiana	3,255	2	28,380	3	28,190	3
Iowa	2,958	4	40,251	2	58,364	1
Missouri	1,712	5	25,094	4	26,510	4
Ohio	3,056	3	22,757	5	24,236	5

The five states shown in the table contained 186,740 rural stations, or 69.9 per cent of all such stations in the United States. Iowa had the greatest development, the reports showing 58,364 telephones, which number was 21.9 per cent of the total for the whole country, and 31.3 per cent of the total for the five states. Moreover, Iowa had 8,924 more rural telephones than any other state. It was in this state, also, that the greatest development of independent rural lines was found—the number of such lines being 1,116, or 22.4 per cent of the total. On these lines there were 18,383 telephones, or 33 per cent of all such instruments on the independent rural lines.

Private stations and pay stations.—From a business aspect substations may be separated into two general classes—private stations and public stations. Private stations are those controlled exclusively by the subscribers who rent them, and used only by such subscribers or their authorized agents. A public station is one not rented to a particular subscriber, but established in some public place, as a hotel, theater, restaurant, drug store, or depot, for the use of the general public, anyone being allowed to use the telephone upon the prepayment of the proper charge.

Classification of private stations.—The private stations can be divided into single lines, party lines, and private branch exchanges. The single line denotes a complete circuit allotted exclusively to a substation. The party lines have two or more substations upon the same circuit. The private branch exchange is a small central office located in the midst of a group of subscribers who desire frequent connections with each other and occasional service to other subscribers outside of their particular circle. These small offices are equipped with switchboards that are in all respects similar to those used in the central offices, and their operators are highly and carefully drilled. Thus the private branch exchange does not differ in any way, except in size, from one of the central offices that compose a large telephone exchange. Its function is not only to relieve the central office of a portion of the labor that is made necessary by the particular group of subscribers, but also to economize wire plant. Thus, A, B, C, and D may wish to talk to one another several scores of times daily, while they have occasion to communicate with F, G, and H (subscribers to the main exchange) only occasionally. Provided A, B, C, and D are close to each other, it is an evident economy in wire plant to serve the several stations by a small switchboard located in their immediate vicinity, rather than to extend their lines and interchange of business to the central office. The private branch exchange consists of a switchboard having short lines extending to each of the substations, while a few trunk lines run from this switchboard to the central office. This type of installation finds a wide and constantly increasing scope in factories, hotels, and offices of large corporations. The tendency now is to make the private branch exchange operator a kind of general confidential clerk, who not only places different substations in connection with each other and with the central office, but also performs many other services. She orders railway accommodations, hacks, or theater tickets, and renders a thousand and one minor services that would be entirely outside the function of the ordinary exchange operator, and she is rapidly becoming a necessary and highly valued employee in the modern business office. In some cases the private branch exchange is so arranged that the instruments of a number of the subscribers can be connected only with each other, while the apparatus of another set of subscribers is such that each one may talk to every other subscriber connected with his particular branch, and also receive service through the main exchange. Technically these two groups of subscribers are called private exchange subscribers and private branch exchange subscribers, respectively.

Classification of pay stations.—Table 46 shows that out of a total of 2,315,297 instruments there were 80,870 pay stations or public telephones; that is to say, the public stations formed 3.5 per cent of the total stations. The public stations were divided into two classes: The so-called automatic or "nickel-in-the-slot" station, which contains a coin box so arranged that the caller must deposit a proper prepayment coin, usually either 5 or 10 cents, for each local call before the connection can be completed, and other pay stations, embracing the miscellaneous instruments. The automatic stations numbered 32,477, or 40.2 per cent. The commercial systems, as shown in Table 48, operated all but 18 of these and all but 384 of the other pay stations. The distribution of the mutual automatic and other pay stations is shown by states and territories in Table 50. New York had the largest number in each case, the reports showing 7 automatic and 53 other pay stations. Table 26 shows the distribution of pay stations by main geographic divisions. There was an average of 972 inhabitants per pay station. The North Atlantic division showed the greatest facilities for telephonic communication, the average number of inhabitants per pay station being only 448, while the South Atlantic division, with an average of 2,044 persons per pay station, had made the least progress.

The American Telephone and Telegraph Company reported 26,573, or 81.8 per cent, of the automatic stations, and 29,083, or 60.1 per cent, of the other pay stations.

Party line stations.—Table 46 contains statistics by states and territories for the party line stations, and Table 47 the number and kind of switchboards; while Tables 48 and 50 show the corresponding totals for the commercial and the mutual systems separately. In the commercial systems the party line stations numbered 808,571, or 36.3 per cent of the total, and averaged 3.2 stations per line. In the mutual systems 77,581 stations, or 86.9 per cent, were on party lines, and the average was 8.4 stations per line. In order to distinguish party lines of commercial and mutual systems from those of rural lines, which are almost invariably party lines, the term party line is restricted to polystation circuits within the corporate limits of a city or town. The commercial companies reported a total of 248,908 party lines and the mutual companies 9,258 party lines. In Tables 29 and 30 a distribution by states and territories is made for commercial and for mutual party line stations.

The rural lines for which statistics are shown in Table 38 had an average of 12 telephones per line, the commercial rural showing 8 and the independent rural, 11.

Magneto and common battery stations.—Technically, substations may be divided into two classes, namely, magneto and common battery substations. The chief difference between the two classes of substations is in the method of providing the electrical energy used in conversation and for signaling. The magneto substation embraces a receiver, a transmitter, a battery to actuate the transmitter, a magneto generator with which to signal the central office, and the necessary apparatus to protect the substation from lightning or abnormal electric currents.

In the common battery substation the source of energy is a battery located at the central office; the exchange uses this battery both to signal and to supply the transmitter. By the use of the common battery the substation is simplified, its installation cost reduced, and its maintenance cheapened. Experience has shown that the larger the territory in which a system operates the less the economy of this latter form of substation. When the subscribers are few and widely scattered, and when the traffic rate is low, magneto apparatus with local battery substation is more economical. When a large number of subscribers are concentrated in a small territory, and the traffic rate is high, the common battery system is a decided gain. Thus in the smaller communities the mutual systems and the independent farmer or rural lines are almost universally constructed and operated upon the magneto plan, while the systems in cities and towns are chiefly of the common battery type. It is difficult to determine where the economical dividing line exists. It is probable that exchanges of less than 500 subscribers can be operated more economically with a magneto outfit, while for those with a larger number of subscribers there is greater economy in using the common battery system.

Table 4 shows a total of 2,371,044 stations, including independent rural lines, but there is no separation showing the proportion of magneto or local and common battery installations, although in Table 5 the number of magneto and common battery switchboards for commercial and mutual lines is given.

Magneto substation apparatus.—The magneto substation apparatus is very diverse, although the tendency has been toward an outfit of which the illustration facing page 22 is a representative type.

The foundation of this apparatus is a solid hard wood backboard affixed to a supporting wall. Upon this backboard is placed a cabinet, having a door and three compartments. The lowest part is a receptacle in which the cells forming the local battery for the transmitter are placed. Formerly the local battery was made of two or three Fuller cells, when the traffic was large, or a pair of Leclanche cells for lighter work. At present the use of dry cells is rapidly growing, since such cells are initially much cheaper, far less expensive to maintain, and free from the objectionable presence of liquid chemicals. The second compartment is somewhat smaller and contains the magneto generator, the right-hand wall being perforated to allow the exit of the small shaft, on the exterior end of which is the crank that enables the subscriber to ring. The top compartment contains the hook switch, which projects through the left-hand wall and on which hangs the receiver. The door supports the ringer, whose gongs are secured on the outside. Below the gongs is the transmitter, usually hinged upon a swinging arm or base, which enables the mouthpiece to be conveniently adjusted to the lips. In the base of this arm a receptacle is commonly formed, in which the induction coil is placed. Underneath the transmitter a shelf is often attached to support the telephone directory, or to serve as a small desk upon which memoranda may be made. A great variety is found in the designs for the arrangement of this apparatus, since every manufacturer offers a number of different patterns in order to suit the taste of various subscribers.

Series and bridged substations.—Magneto substations may be divided according to the arrangement of the ringing apparatus into series circuits and bridging circuits. There is an analogy here between

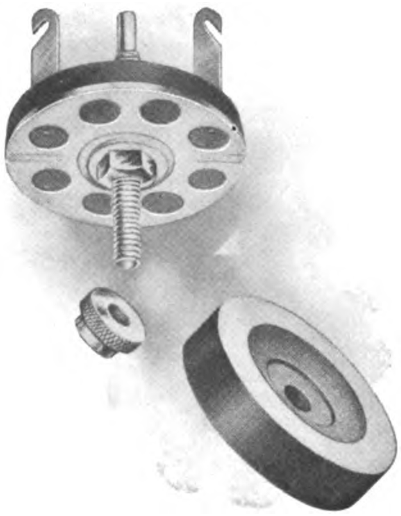


FIG. 1.—LIGHTNING ARRESTER.

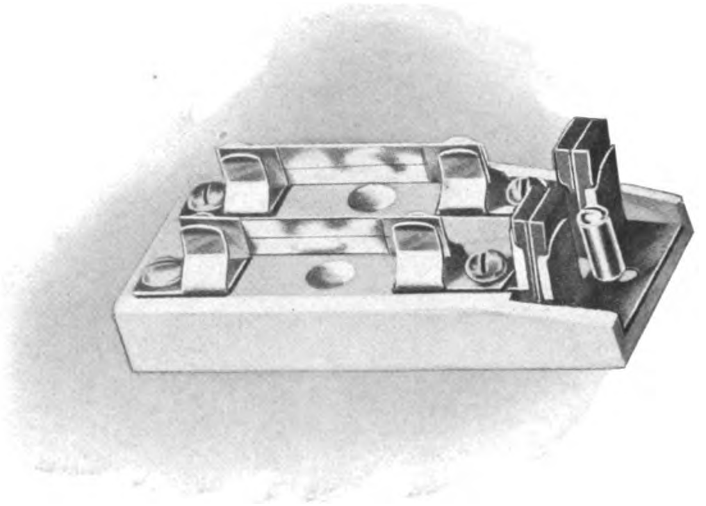


FIG. 2.—COMBINED FUSE AND LIGHTNING ARRESTER.

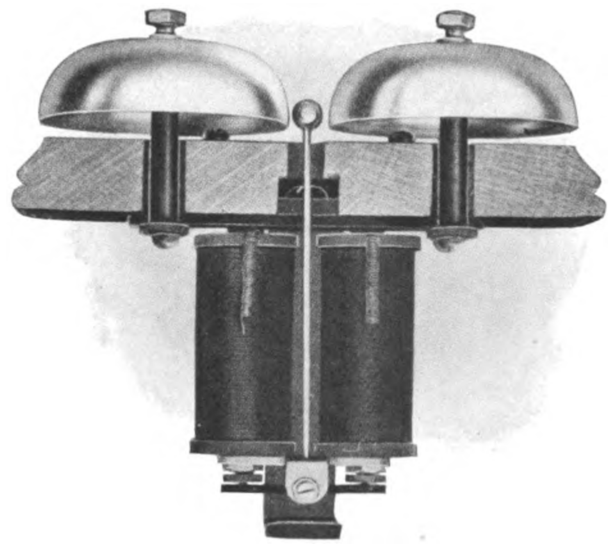


FIG. 3.—MAGNETO BELL.

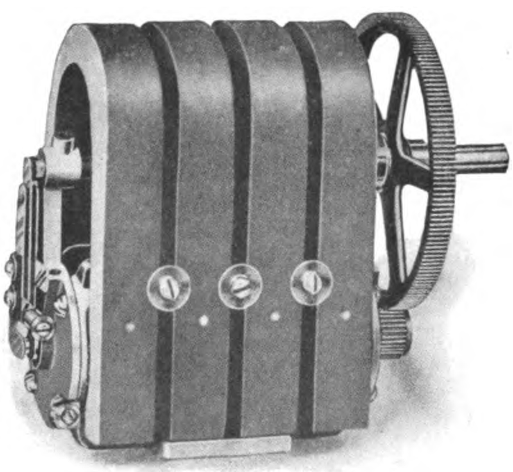


FIG. 4.—MAGNETO GENERATOR ASSEMBLED.

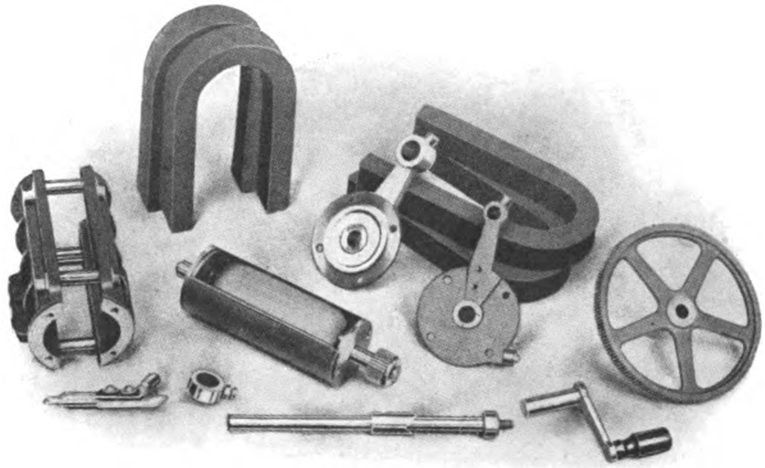


FIG. 5.—MAGNETO GENERATOR DISSECTED.

the series method in electric lighting with arc lamps and the multiple or parallel method of lighting with incandescent lamps. The older, or series, type of telephone is usually provided with a bell of comparatively low resistance—that is, 60 to 80 ohms—and a magneto generator having its armature normally shunted when not in use for ring signaling. With the best arrangement of this type it is impracticable to place a large number of instruments in series and secure satisfactory transmission, because of the attenuation of the current in passing through so many mechanisms. The instruments of the bridging type are so adapted that they can be placed in multiple or bridging relationship with the line, and now they are commonly so placed for party lines having more than one substation. The illustration (Fig. 1) facing page 26 shows a bridging set with local battery transmission.

The bridging telephone set is provided with a bell magnet of high resistance and a generator that has its armature on open circuit instead of being shunted, as in series instruments. A permanent bridging arrangement across the line might appear to be injurious to the transmission of speech, since it tends to shunt incoming and outgoing current for talking, but, as the bell is wound to a resistance of from 1,000 to 2,000 ohms, it presents so great an impedance to high frequency telephonic current that practically no difference can be detected; moreover, with such a circuit it is practicable to place a large number of instruments upon the same line and yet secure commercially satisfactory transmission. Hence multiparty lines have become a possibility and have been adopted widely.

A number of modifications of this circuit are made by arranging the pieces of apparatus (transmitter, receiver, local battery, induction coil, generator, and bell) in different relations to each other, and sometimes the ground is resorted to as a circuit through which the substation bell may be rung. But all such modifications include the fundamental principle of so locating the apparatus that the talking circuit is cleared during conversation and the signaling circuit subsequently restored.

Common battery apparatus.—In common battery, or, as they are frequently called, central energy systems, a large battery placed at the central office is utilized as the common source of supply of current to the transmitters of all subscribers connected with that exchange. It is also possible to utilize this source of electricity as the means of signaling.

This is done by permanently connecting the battery to each subscriber's line at the central office. So long as the receiver is on the hook switch, the line is opened at the substation and hence no battery current traverses it. When the receiver is removed, the hook switch closes the circuit and current from the battery commences to flow. If a relay is interposed in the circuit, the current from the battery excites it, and it attracts the relay armature, which can be arranged to actuate any form of signal, although a small incandescent lamp is the one usually adopted. Hence the mere removal of the receiver is sufficient to signal the exchange. Therefore a common battery station differs from a magneto station in the omission of the ringing generator and the local battery; consequently the substation outfit may be correspondingly smaller and cheaper. A subscriber set for use with central battery is shown in Fig. 2 of plate facing page 26.

Substation receivers.—One type of telephone receiver is shown in Fig. 2 of plate facing page 28. The illustration facing page 30 is another type of the receiver (Fig. 1) with a partial section (Fig. 2) and a dissected instrument (Fig. 3).

While the instrument is called a receiver, it can also be used in a limited way as a transmitter. In a case made of hard rubber or similar material, and resembling a butter stamp, a magnet is inserted. This magnet consists of a U-shaped permanent magnet of hard steel, on the ends of which are two pole pieces of soft iron, which carry coils of fine insulated wire. The terminals of the coils run to conductors contained in a flexible cord extending through a hole in the rear of the case. Directly in front of the pole pieces is the diaphragm, a circular disk of iron, usually ferrotype metal, about two inches in diameter and from one one-hundredth to one-fiftieth of an inch in thickness. The diaphragm rests upon the face of the case and is secured thereto by means of a hard rubber ear piece or cap, threaded upon the end of the case, which locks the diaphragm in place as close to the pole pieces as possible without touching them.

The magneto receiver is, as noted above, a reversible telephone. When sound waves impinge upon the diaphragm, it vibrates; this motion causes changes in the magnetic field created by the permanent magnet, these changes resulting in electrical impulses in the pole piece coils that produce a current in the attached line. If these impulses reach another receiver at the other end of the line, they produce exactly corresponding changes in its magnetic field, and so cause its diaphragm to vibrate, reproducing at the distant end a series of sound waves precisely similar to, though somewhat less in amplitude and in volume than, the originating ones. Telephonic communication, therefore, can be carried on simply by means of a line and a pair of magneto telephones, but the action of the magneto instrument is too feeble to be commercially effective. Therefore an instrument that could produce more powerful results became necessary and the battery transmitter was invented.

Substation transmitters.—It is common to find the telephone transmitter mounted on a swinging arm fastened to the woodwork of the substation set.

A transmitter head is shown in illustration (Fig. 1) facing page 34, and a cabinet set transmitter, in Fig. 1 facing page 28.

Another prevalent type is the desk set, in which the transmitter is supported on a small metal pedestal which carries the hook switch supporting the receiver. See illustration (Fig. 4) facing page 30.

In theory the battery transmitter operates as a kind of electric valve, whereby power derived either from a local battery or a central office battery is used in transmission, the office of the transmitter being simply to deliver this energy intermittently to the line in undulatory impulses corresponding to the sound waves that impinge upon its diaphragm.

The working parts of the transmitter are usually inclosed in a cup-shaped receptacle of spun brass, which is covered by a substantial face plate, into which the mouthpiece opens, the whole being supported upon the pedestal or arm. Figures 2 and 3 on plate facing page 34 show a sectional view of the working parts, and the assembled transmitter with the protecting brass cup removed.

From the sectional view it will be seen that the working parts consist of a substantial brass piece, *b*, known as the bridge, which, according to Fig. 3 is clamped firmly to the face plate. The bridge supports a brass cup, to the bottom of which a carbon electrode, *r*, is attached. As the bridge forms a substantial support for the cup and its inclosed electrode, this type of transmitter is known as the solid back. Over the face of the cup is placed a mica diaphragm, *a*, which is held in place by a brass ring screwed to the face of the cup. This mica diaphragm carries a second carbon electrode secured to a stud running through the mica diaphragm and attached to the main diaphragm, *d*, by means of a nut. The space between the two carbon electrodes is filled with fine granular carbon. The mouthpiece, *m*, is directly in front of the diaphragm, which is pressed against the face plate by means of two springs. Sound waves entering the mouthpiece impinge upon the diaphragm, causing it to vibrate. As the electrode, *f*, is flexibly connected to it, the motion is transmitted to this electrode and causes the pressure that it exerts upon the carbon granules to vary. One pole of the local battery is connected to the rear electrode and the other to the front electrode. In some manner, as yet but imperfectly comprehended, the changes in the pressure upon the carbon granules cause a considerable variation in electrical resistance, and hence this mechanism causes pulsations of current from the battery to flow through the circuit, and, as these pulsations are far greater in intensity than those produced by the magnetic telephone, the battery transmitter talks correspondingly louder and more clearly.

The induction coil.—The effect upon the receiver depends not upon the total current flow, but rather upon the magnitude of the fluctuations. If a transmitter, receiver, battery, and line be connected in series, the magnitude of any particular fluctuation will depend solely on the ratio of the change in the resistance created in the transmitter to the total resistance.

If the transmitter be placed in a local circuit, and a small transformer be used to impart the transmitter impulses in the local line to the main circuit, then it is easy to make the transmitter resistance form a very large part of the total in the local circuit and the impulses become correspondingly accentuated and effective. Such is the function of the induction coil. Further, by the transformer action of the induction coil, a low voltage and large current in the local circuit are transformed into a high voltage and small current in the transmitting circuit, and hence better transmission of speech may be secured. The induction coil usually consists of a core of soft iron wire, upon which is placed a primary winding of silk-covered copper wire, surrounded by an appropriate thinner secondary winding, the whole being inclosed to prevent injury.

Signaling apparatus.—Magnetic signaling apparatus consists of two parts—a generator to produce the necessary alternating current and a magneto bell to be operated thereby. Figures 4 and 5 on plate facing page 36 show a common type of generator and the various parts of the mechanism.

The generator consists of from two to eight U-shaped permanent magnets, bolted to an iron frame that carries a shaft, to which a gear wheel and crank are attached. The gear wheel meshes into a pinion placed upon the shaft of a shuttle-wound armature that rotates between the poles of the magnets. Therefore, when the crank is turned, the armature is revolved rapidly and an alternating current is produced. Thus this machine is merely a magneto dynamo on a sufficiently small scale to be easily actuated by hand.

A magneto bell is shown in Fig. 3 on plate facing page 36. This bell consists of a frame which supports a pair of gongs, a pair of magnet spools, a U-shaped permanent magnet, and an armature pivoted in front of the poles of the electro-magnets, carrying a clapper so arranged that when the armature swings, the clapper will strike against the edges of the gongs.

The magneto call possesses the advantage that it contains no contacts to corrode and requires no battery maintenance, while the generators can be easily built to give sufficient pressure or voltage of current to operate the longest line.

Protection of substation.—The telephone line often is accidentally crossed with other conductors carrying dangerous potentials or large currents and the aerial circuit is sometimes struck by lightning. Either contingency may damage the substation, expose the

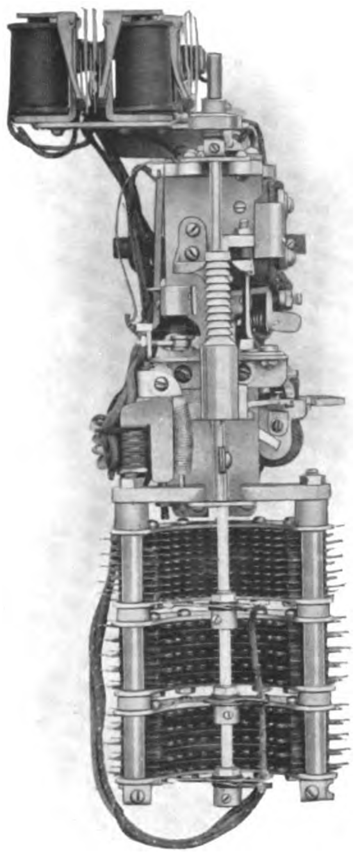


FIG. 1.—AUTOMATIC TELEPHONE SWITCH, CENTRAL STATION.

FIG. 2.—AUTOMATIC TELEPHONE DESK SET, SUBSCRIBER'S STATION.

FIG. 3.—AUTOMATIC TELEPHONE WALL SET, SUBSCRIBER'S STATION.

FIG. 4.—AUTOMATIC TELEPHONE, WALL SET SHOWING PARTY CALLING.

building to fire, or inflict upon the user a disagreeable or dangerous shock. Hence it is customary to equip substations with devices whose object is to isolate the substation before damage can be done. Such contrivances are usually termed protectors. Lines that are entirely underground are virtually free from danger from lightning, and, when inclosed in conduits, contact between them and other circuits is so rare that present practice inclines to the omission of protective devices altogether. Such devices are applied, however, to the portions of the line upon poles.

Abnormal currents are either of excessive potential or of excessive quantity. No single device has been found sufficient to guard against both forms of abnormal current, so that the present protector embraces one contrivance to protect against high potential discharges and another to guarantee against sneak currents. The common form of the high potential portion, often termed a lightning arrester, is a spark gap, which consists of a pair of carbon plates, one of which is grounded while the other is connected to the line, the plates being separated by a thin perforated mica washer from one two-hundredth to one one-hundredth of an inch in thickness. See illustration (Fig. 1) facing page 36.

Usually a protector is placed upon the backboard of the substation set, although it would afford better protection to the building if it were located on the outside of the house wall. Frequently a small cavity is excavated in one of the lightning arrester carbon plates, in which a button of easily fusible metal is placed. The heat of a discharge between the plates deadgrounds the line and protects the station from further injury.

The spark gap as thus constructed has proved itself efficient to protect apparatus from high potential discharge, but, in order not to interfere with the normal operation of the telephone line, the spark gap must present an air space of at least one two-hundredth of an inch, or the normal ringing current will jump the gap and short circuit the line. Consequently the spark gap does not afford protection from currents of less than two hundred or three hundred volts. To prevent injury from sneak currents, the protector must be further equipped with some device which shall open the circuit in case current values exceed a dangerous amount. This is usually a fuse or heat coil. The fuse is of the simplest form and is frequently a strip of mica about one inch in length, supplied with copper terminals connected by a bit of fine copper or German silver wire, either stretched straight between the terminals or wound in a helix around the mica. A combined double-pole lightning arrester and fuse is shown in illustration (Fig. 2) facing page 36.

As fuses are somewhat uncertain devices, the so-called heat coil is also provided as being more reliable. This consists of a coil of fine wire wound upon a core placed in series with the line, the core consisting of a movable pin that normally is soldered in its place by easily fusible metal. The heat coil is held in a pair of springs in such a manner that the pin is insulated. If an abnormal current enters, the heat developed in the coil is sufficient to melt the solder and allow the pin to fall upon a grounded plate. Further, the device is usually so contrived that the pin may open the portion of the line inside of the building, while it grounds the external conductor.

Between the heat coil and the line it is customary to insert a fuse formed of a lead wire four or five inches in length, inclosed in a fiber tube. When the heat coil operates and grounds the line, it removes the resistance of all apparatus beyond it. Then, usually, sufficient current traverses the line to melt the lead fuse and this opens a gap long enough to break the circuit completely.

Automatic stations.—Among the more recent forms of telephone substation are those known as automatic. These depend upon central offices where the lines are interconnected by devices that dispense with the service of an operator at the switchboard. Views of this apparatus are given in plate facing page 38.

Desk and wall sets are shown, and the action of the subscriber is illustrated when setting the signal dial at his station on the numerals of the desired line, so that the mechanism at the central office will receive the call automatically and select the circuit wanted, as well as call up the subscriber there.

CHAPTER VII.

THE WIRE PLANT.

Governing conditions.—The wire plant of a telephone system forms the connecting link between the substation and the central office. In the construction of the first telephone lines the practice that had been established by the telegraph companies was closely followed. Iron wire, supported upon wooden poles, as well as small glass insulators, cross arms, pins, and other line accessories of the types that telegraph practice had sanctioned, were used. As in telegraphy, the earth was employed as one side of the telephone circuits. Because of its rapid adoption the telephone soon demanded, particularly in urban districts, so large a number of wires as to cause the pole to become an intolerable nuisance; while the simultaneous development of other electrical industries—particularly the street railway—that also utilized the earth for completing the circuit, caused grounded lines to become so noisy as to render speech transmission uncommercial and often impossible. From an electro-magnetic standpoint iron wire is objectionable, and its ability to withstand corrosion from atmospheric influences is much less than that of copper. Therefore the present tendency is in the direction of abandoning the earth as a return and using a complete copper metallic circuit of wires inclosed in cables, either laid in underground conduits in urban centers or supported upon poles in the less densely settled districts, the open-wire line being relegated to short distribution, to sparsely settled rural localities, or to toll and long distance lines, where the greater electrostatic capacity of the cable renders its use objectionable.

Statistics of wire circuits.—In the outlying districts, as shown in Table 3, there were 5,518 miles of wire, or 1.909 miles per telephone, while in continental United States, as shown in Table 4, the total quantity of telephone line wire reported as in use by all systems, including independent rural lines, was 4,900,451 miles, or 2.067 miles per telephone. The commercial systems employed 97.5 per cent of the total mileage; the mutual systems, 1.5 per cent; and the independent rural lines, 1 per cent. Table 5 shows that the commercial telephones used 2.147 miles of wire per telephone and the mutual systems, 0.794 of a mile. The Bell companies, as shown in Table 6, operated 3,387,924 miles, or 69.8 per cent of the total, having 2.572 miles of wire per telephone. The independent companies returned 30.2 per cent of the wire mileage, showing 1.465 miles per telephone. The wire mileage of the Bell companies is greater than that shown by the independent companies, because the former control considerably greater mileage of toll lines and because the Bell exchanges of each system are connected by trunk lines. It is rare for an independent local exchange or system to have more than one office.

Wire mileage by geographic divisions.—The distribution of wire mileage by geographic divisions is shown in Table 8 for all systems, in Table 9 for the commercial systems, in Table 11 for the mutual systems, and in Table 38 for the rural lines. The North Central division had the greatest mileage for all systems and for each class of systems. The fact that the mutual lines in this division utilized 81.6 per cent of the total mileage for mutual systems is worthy of note.

Wire mileage of rural lines.—Table 38 contains a complete analysis of wire mileage for rural lines. The total length of wire was 259,306 miles, or an average length of about twelve miles per line. The corresponding averages for commercial rural and for independent rural lines were about nine and ten miles, respectively. The length of wire per telephone for commercial rural lines was 1.136 miles, and for independent rural, about nine-tenths of a mile. From Table 39, which shows the rank of the five states containing the bulk of the rural lines, it is seen that Illinois had the greatest wire mileage, 47,463 miles, or 0.96 of a mile of wire per telephone.

Underground, overhead, and submarine wires.—Table 46 contains the detailed statistics concerning wire mileage and shows data relating to underground lines, aerial lines, and submarine cables. Of the 4,850,486 miles of wire reported, 3,150,444, or 64.9 per cent, consisted of wire above ground, and 1,690,502, or 34.9 per cent, of wire underground. The remaining 9,540 miles consisted of wire in submarine cables. There were on the average 231.9 miles of wire in each mile of underground cable, making an average of 116 pairs of wires per cable. The largest amount of underground construction was in New York state, which reported 2,130 miles of duct, 1,571.7 miles of cable, and 392,973 miles of single wire; but Pennsylvania had more duct than New York by 1,988.4 miles. In underground wire mileage Pennsylvania was second, with 249,246 miles; Ohio third, with 153,677 miles; and Massachusetts fourth, with 148,707 miles. There were eight states and territories which did not report any underground construction.

Of the overhead wire mileage 2,369,914 miles, or 75.2 per cent, consisted of wire on pole or roof lines, and 780,530 miles, or 24.8 per cent, of overhead cable. The total length of overhead cable was 8,104.5 miles, so that the average wire mileage per mile of cable was 96.3 miles, making an average of 48 pairs of wires per cable. In miles of wire in overhead cable Ohio ranked first, with 114,473 miles; New York second, with 82,967 miles; Pennsylvania third, with 73,670 miles; and Illinois fourth, with 71,251 miles.

The total wire mileage in submarine cables was 9,540. Of this amount, 3,267 miles, or 34.2 per cent, was reported from New York state; 1,034 miles, or 10.8 per cent, from Michigan; and 996 miles, or 10.4 per cent, from New Jersey.

Miles of wire per system and station.—Tables 29 and 30 show, for states and territories, the average number of miles of wire per system and per station. It appears that for continental United States the commercial systems averaged 1,514 miles per system and 2.15 miles per station. The mutual systems showed 71 miles per system and 0.79 of a mile per station. Massachusetts showed the greatest commercial mileage per system, 25,746, but the station mileage was 2.67. California showed the greatest mutual mileage per system, 154, but its station mileage was third. Texas stood first in mutual station mileage, with 2.91, and Colorado second, with 2.50.

Kind of poles used.—The pole is the foundation of the open line. In states of the North Atlantic and North Central divisions chestnut is largely used, and in those of the South Atlantic and South Central divisions juniper, cypress, cedar, and sometimes southern pine are employed, although the pine and the cypress rot so rapidly as to make the maintenance of such poles an expensive item. In states of the Western division the various kinds of pine and fir, imported from the North Pacific coast, prevail. The following tabular statement shows the usual size of poles:

Table of pole sizes.

Length (feet).	Circumference (inches). At top.	Circumference (inches). 6 feet from butt.	Approximate average weight (pounds).	Length (feet).	Circumference (inches). At top.	Circumference (inches). 6 feet from butt.	Approximate average weight (pounds).
20	12½	24	100	40	22	40	625
20	16	25	130	40	25	43	800
25	12½	24	150	45	22	43	835
25	16	25	200	45	25	46	1,000
25	17½	26	250	50	22	46	1,035
25	19	27	350	50	25	50	1,250
25	22	30	350	55	22	50	1,500
25	25	34	375	55	25	54	1,550
30	19	30	275	60	22	54	2,000
30	22	34	350	60	25	58	2,000
30	25	37	450	65	22	58	2,700
35	22	37	450	70	22	64	3,400
35	25	40	600				

Cross arms are usually made of yellow pine. The following tabular statement shows the accepted dimensions of cross arms:

Table of cross arms.

Length (feet).	Number of pins.	Pin spacing (inches). Ends.	Pin spacing (inches). Sides.	Pin spacing (inches). Centers.	Approximate weight (pounds).
3	2	4	....	28	10
4	4	4	12	16	14
5	4	4	15	22	17
6	4	4	21	22	21
6	6	4	12	16	21
8	6	4	16½	22	28
8	8	4	12	16	28
8½	10	3	10	16	29¾
10	8	4	15	22	35
10	10	4	12	16	35
10	12	4	9⅝	16	35

In the top of the pole a series of gains is cut of such size as to receive the squared center of the arm which is bolted to the pole, sometimes by a five-eighth or three-quarter inch machine bolt and sometimes by a lag screw. In this way the arm is supported.

To stay each cross arm, two cross arm braces are used. These are of iron, 28 inches long, one and one-fourth inches wide, and one-fourth of an inch thick. Each brace has a hole drilled at either end, one end being secured to the cross arm about ten inches from the center by means of a carriage bolt four and one-half inches long and three-eighths of an inch in diameter, and the other being attached to the pole by means of a lag bolt five inches long and one-half of an inch in diameter. The insulator pins, which are usually of locust, are driven into the cross arms, and secured by wire nails. There is said to be an increasing tendency toward the use of iron pins, which as a rule are composed of shanks of mild steel or iron, from one-half to five-eighths of an inch in diameter. These pins support threaded wooden plugs cut to receive the insulators, or else the insulators are set upon the ends of the iron pins and secured by plaster of Paris. The so-called pony insulators, made of bottle green glass, are almost universally used for the line wire. Porcelain insulators have been tried, but, as they are more expensive and have proved but slightly more efficient, they have not been used extensively. The line wire is usually secured to the insulator by a tie wire of the same size and material as the line wire. The length of the tie wire varies from 16 to 22 inches, depending on the size of the line wire. Line wire is of hard drawn copper or of iron. Short lines are usually of No. 10 or No. 12 B. & S. wire, while for toll and long distance work No. 8, or occasionally No. 6, wire is employed.

It is customary to secure the line to the insulator by placing the wire in the groove of the insulator and wrapping around it a piece of tie wire. Iron wire is usually spliced by the familiar Western Union joint, made by wrapping the ends of the wire for three or four inches and then twisting them together. Hard-drawn copper wire can not be so treated, because a twisted joint ruptures the hard skin, in the integrity of which lies its strength. The copper wire is spliced by the McIntire joint. This consists of two parallel copper tubes, of the proper size to fit the wire. The end of one wire is inserted into one tube, and the end of the other wire into the other tube, then the tubes are twisted tightly, making a joint whose strength is nearly equal to that of the wire itself.

Transmission over long telephone lines is likely to be affected by the inductive action, either of the neighboring telephone wires or of other electrical circuits. As a preventive, it is customary to so transpose the various wires that they may twist around each other and occupy different positions with reference to neighboring lines. Transpositions are usually made with a special insulator, whereby each line to be transposed is terminated, and then by means of a cross wire changed from one insulator to the other.

Telephone cables.—The invention of the so-called paper cable has completely revolutionized the building of telephone lines, by providing a method whereby, at small cost, a large number of conductors can be compressed into a small space and yet preserve requisite insulation without objectionable increase of electrostatic capacity. To make paper cables, soft drawn copper wire of 18, 19, 20, or 22 gauge is insulated by covering it with a double wrap of tissue paper. Each metallic circuit consists of two such wires twisted together in a strand having a lay of from 4 to 6 inches. The proper number of such strands to form the desired cable are then cabled by using one pair for the center and laying up around the central pair layer after layer of circuits, each being cabled in a direction reverse to the other. Finally the whole mass of wire thus arranged is inclosed in a lead pipe, which hermetically seals the conductors in an absolutely moisture-proof sheath. By the spiral arrangement the inductive effects of adjacent circuits are nullified, for, as each pair of wires is twisted with a lay of about six inches, each side of each circuit is mutually transposed twice in every foot, and, as the different layers are spiraled in reverse order with a lay of about twenty-four inches, each circuit as a whole is frequently transposed with reference to all others. In the use of a loose wrapping of paper an insulating material is secured, which possesses, so long as it is kept dry, an exceedingly high insulation resistance, combined with great lightness and flexibility and low specific inductive capacity. Thus the paper cable secures an almost ideal arrangement for telephonic circuits, but its permanence depends on the integrity of the lead sheath, its only protection from moisture, which would immediately ruin all the circuits.

Paper cables are made to contain from four or five pairs of wires for distribution to six or seven hundred pairs for main line work. Three varieties, differing chiefly in the size, are in common use. Subscribers' cables are those employed for the shortest lines, where a relatively high conductor resistance and electrostatic capacity are of minor importance. Trunk line cables use a larger gauge wire and have a lower capacity, and toll line cables have the least conductor resistance and the lowest capacity.

From a mechanical standpoint the paper cable has little strength. The lead of the sheath is intrinsically weak and the copper wires, that with their paper wrappings form the core possess little mechanical strength. Hence telephone cables must be carefully supported and not allowed to sustain their own weight over long spans. When cables are to be used upon pole lines, it is customary to run a steel wire rope, termed a messenger wire, from pole to pole, and hang the cable thereto by means of clips. Upon each pole the messenger wire is supported by means of either a special angle iron cross arm, or an iron bracket.

As it is impractical to manufacture paper cables of more than from four to five hundred feet in length, frequent splices are necessary. The cable is prepared by stripping the lead about twenty-four inches at each end. A lead sleeve, about eighteen inches long and with a diameter from one inch to one and one-half inches greater than that of the cable, is slipped over the ends. Then the paper wrapping is removed from the wires and over each a paper sleeve is placed; the ends are twisted together and the paper sleeve is slipped over the bare portion. To remove any absorbed moisture the cable joint is boiled in paraffin. Then a wrapping of tape is bound firmly over the generators. The lead sleeve is slipped over the splice, the ends are dressed down, and the sleeve is soldered to the respective sheaths.

Telephone cables terminate usually either at a central office or upon an open wire distributing pole. At the end of the cable the conductors must be brought out. There are two devices for accomplishing this, the cable head and the pot head. The former consists of a rectangular iron box, having at one end a brass pipe to which the sheath of the cable is soldered and through which the conductors pass to the inside of the head. The sides of the head are provided with binding posts, which project, air tight, through the sides. After each conductor is run to its appropriate binding post and soldered, the head cover is screwed down upon a rubber gasket, sealing the cable. The pot head is the cheaper device. It is made by splicing a short handmade cable to the cable in the manner already described. To prevent moisture from entering the cable, the sleeve is made somewhat longer, the pot head is set on end and heated to

TELEPHONE CONDUITS NEAR STREET RAILWAY TRACK.

GROUP OF 24 DUCTS IN TELEPHONE CONDUIT SHOWING STANDARD PRACTICE.

about 300° F. and the sleeve is filled with melted chatterton or other cable compound, which unites with the rubber covering of the leading out wires.

Telephone conduits.—A telephone conduit is a long longitudinal passageway which is built beneath a highway and in which one or more cables may be placed. In the first efforts to build underground lines the simple plan was adopted of burying a cable either directly in the ground or in a trench or box filled with sand. But this means that the cable is inaccessible unless the pavement is lifted, hence such built-in systems were found to be impractical. For the so-called drawing-in systems pipe-like passageways are built in the streets so that they open at intervals of from 200 to 400 feet into vaults or chambers which afford access to the ducts. Thus the conduit and the cable are entirely distinct, and cables may at any time be introduced or removed with no interference to the street surface.

Many feet of conduit have been built of wrought iron pipe embedded in concrete, with the idea that the iron pipe would form a convenient receptacle for the cable, and that, if it should rust away, an equally useful hole in the concrete would remain. A formidable objection was the expense of the iron pipe. To cheapen conduit construction some unknown person employed a terra cotta drainpipe, and upon this simple and apparently obvious expedient the whole modern system of terra cotta conduit building is based.

Two forms of clay ducts are now in use—the single duct, or hollow brick, and the multiple duct. The single duct is made of pieces of rectangular clay pipe about 18 inches in length and 5 inches in diameter over the flat sides and has a longitudinal hole about 3 inches in diameter.

In the street a trench is excavated of sufficient size to accommodate the desired number of ducts. Upon the bottom of this trench a layer of concrete from 3 to 5 inches in thickness furnishes a surface with adequate foundation and a proper grade for drainage and ventilation. The conduits are built by laying the tiles in brick-wall fashion. Each duct is embedded in a layer of cement mortar, and, in order that the successive ducts may be properly aligned, they are laid on a mandrel, which is a round stick about 5 feet in length placed in each duct and drawn along as fast as a new brick is laid, so that the successive pieces are centered by means of the rods on which they rest. As these hollow bricks are short, the laying requires considerable labor; moreover, the trade unions have held that the use of a trowel brings the construction of the conduit within the definition of masonry, and hence they apply to it the wage rate of skilled masons.

The so-called cement lined pipe has been extensively used, and many believe that its use is advantageous. The duct material is composed of cement pipe, made by molding cement around a mandrel placed inside a thin iron tube about 5 feet in length, the reason for the use of the iron casing being the protection of the cement while it is hardening. Conduits of cement lined pipe are built as already described, the space between the tubes being filled with mortar, while alignment is secured by providing the successive pieces of duct material with male and female ends.

The multiple duct is a recent development. The difference between it and the single hollow brick is that in the multiple duct from two to-twelve ducts are combined in one piece, and therefore the labor of handling and laying is reduced. Thus a 16-duct subway can be composed of four pieces of 4-duct tile. The duct material is laid upon a concrete bed. Consecutive pieces are aligned by means of dowel pins, which are inserted into holes in the partitions between the ducts, while joints are formed by wrapping the ends of the successive lengths with burlap coated with asphalt or cement mortar.

In order that cables may be introduced into the conduit it is customary to provide chambers which are called manholes or vaults. These must be placed where the conduit makes a marked change in direction, as it is inexpedient to pull cables around corners. As the street corner forms a convenient location for the manhole, these chambers are usually placed from 200 to 400 feet apart. The manhole is made either of brick or of concrete and is provided with one of the many different designs of iron covers now in use, so that the continuity of the street level may be preserved and access to the chamber afforded.

In building conduit manholes a concrete bottom from 6 to 8 inches in thickness is usually made at the lowest part of the necessary excavation, and in this a sewer trap is placed to serve as an outlet for any surface water that may enter. Upon the concrete bottom the manhole itself is constructed. When concrete is employed it is customary to make a collapsible mold, nearly filling the excavation, and to ram the concrete on top of the mold and between it and the surrounding earth, thus making a thick monolithic chamber. The concrete manholes cost about three-fourths as much as the brick manholes, and are considerably stronger after the concrete is thoroughly set and much more efficient in resisting the predatory pick of the street paver.

CHAPTER VIII.

CENTRAL OFFICE OR EXCHANGE.

Definition of central office.—The Bureau of the Census employs the terms "public exchange" and "central office" to designate the place where the larger switchboards are located for the purpose of interconnecting subscribers' telephones.

It is the function of the central office to place the subscribers in talking relations with each other and to disconnect their lines when conversation is completed, in readiness for new calls from other persons. All its apparatus and all the energy of its operators must be bent toward performing the necessary functions with the utmost celerity and economy. Many systems have a main exchange and a number of public branch exchanges, or branch central offices; all of those having switchboards were considered and counted as public switchboards and public centrals. The 10,361 public exchanges shown in Table 46 therefore represent the entire number of offices which were used for the purpose of interconnecting subscribers' substations. The 4,985 independent rural lines from which reports were received did not operate any central office.

Telephone switchboards.—The switchboard is the chief and most important feature of the central office, because the success of the system as a whole depends upon its proper operation.

For continental United States the total number of switchboards of all kinds was 10,896. This exceeds the number of public exchanges by 535. This difference is due partly to the fact that toll boards and local boards were returned separately for the exchanges in which there were separate installations for these two forms of service.

In general, switchboards may be classed as manual or automatic.

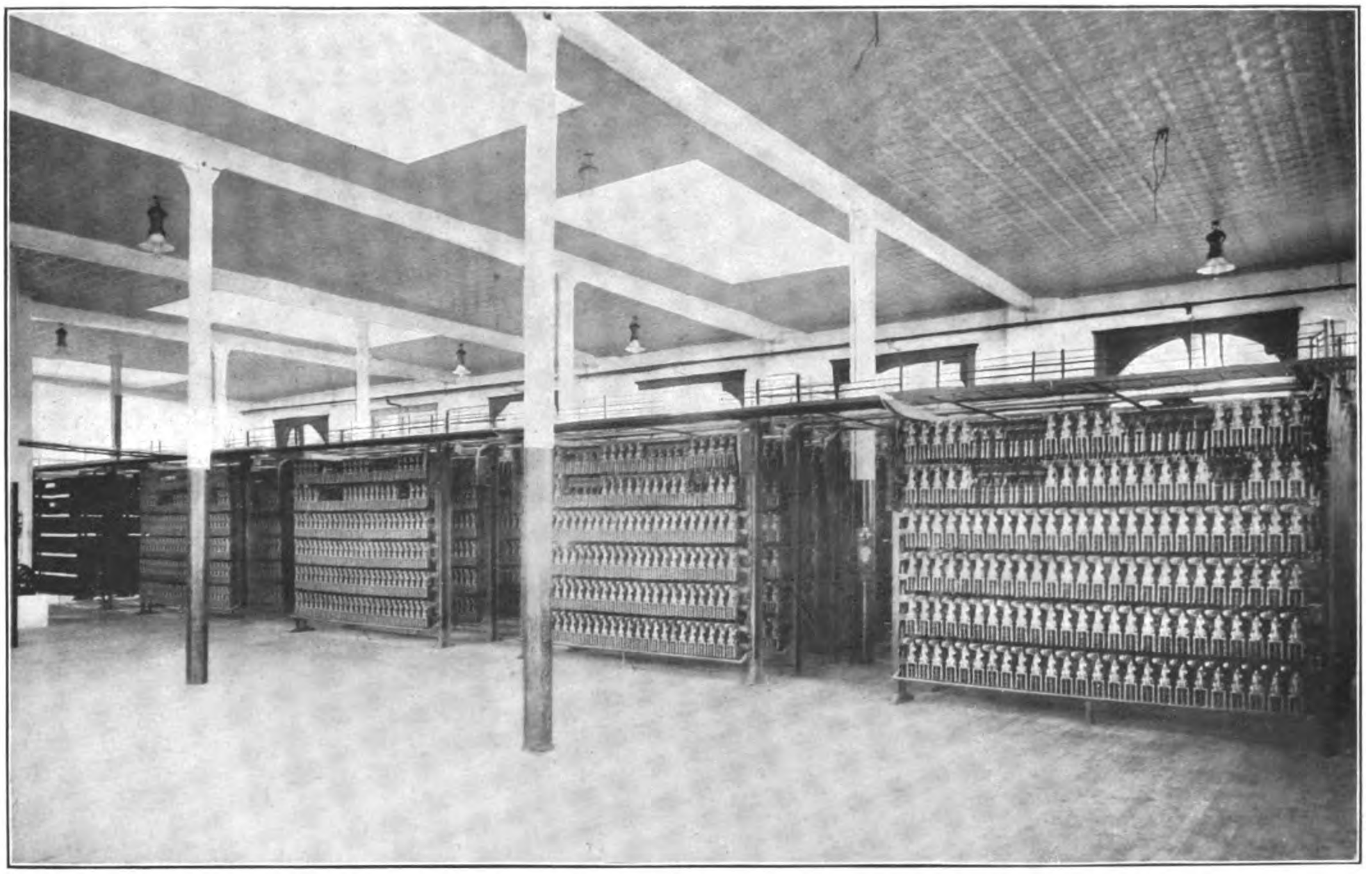
An automatic switchboard is one that does not depend upon the service of an operator, but is worked by the subscriber himself from his substation. Automatic switchboard substations are provided with some form of mechanism which the subscriber sets to the number of the correspondent whom he desires. This mechanism then transmits to the central office a series of electrical impulses, that actuate an electromagnetic mechanism in the switchboard, usually upon the step by step plan, whereby the subscriber's line is automatically connected to that of the desired correspondent. While the problem of the automatic exchange has been under process of solution for a number of years, there were only 54 switchboards of this type in practical operation in 1902, which shows that they were then comparatively unimportant, although the number appears to be increasing very rapidly.

The manual switchboard is so called because connections between subscribers are made manually by operators, who connect the lines of different subscribers by means of plugs joined by flexible conductors, all connections being made in accordance with the oral instructions of the calling subscribers. According to Table 5, there were 10,842 manual boards, which were divided into common battery and magneto boards.

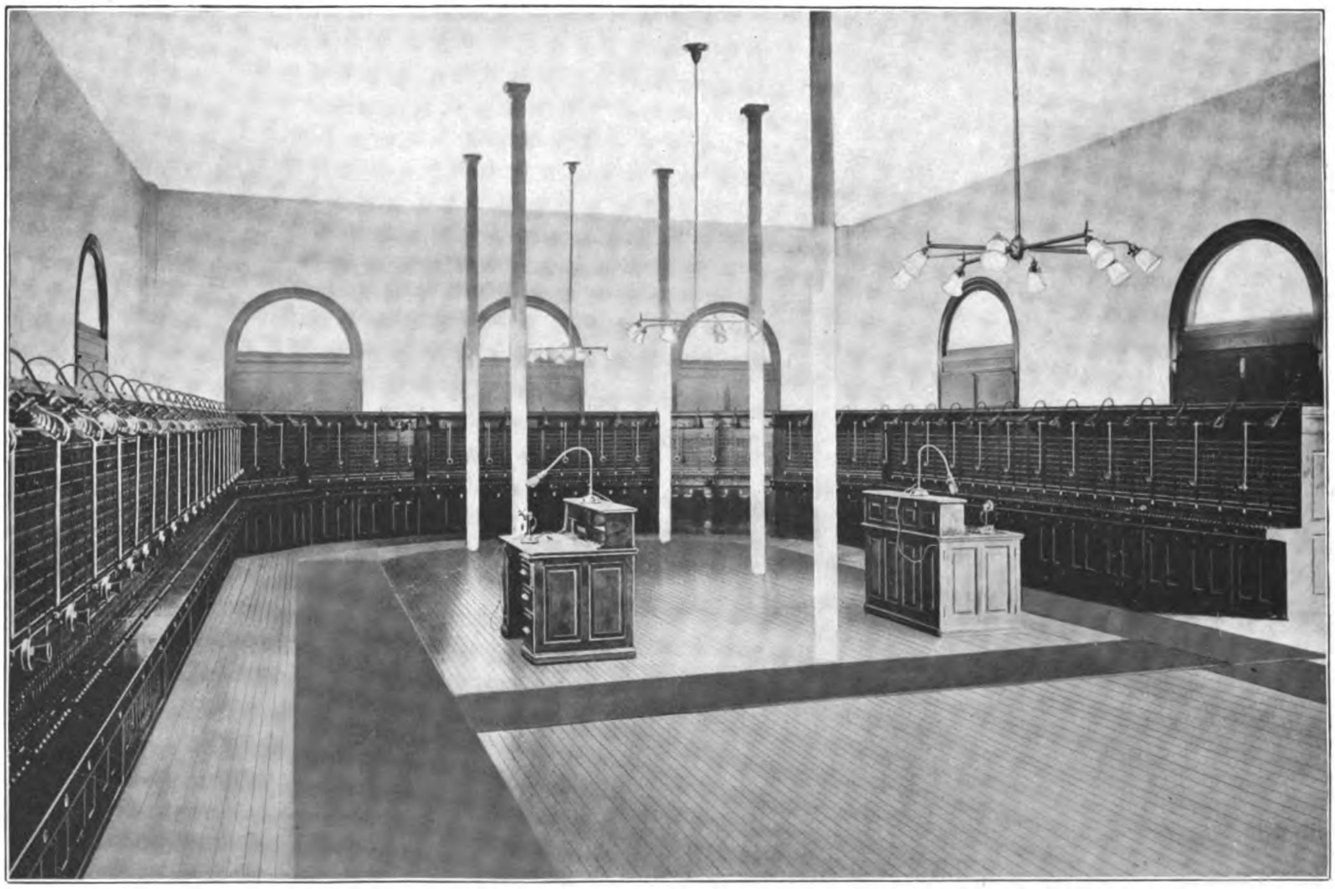
Common battery boards may be defined as those that use a central office battery to supply the energy for the transmitters and for signaling to all of the substations attached. Magneto boards are those that serve systems in which each substation has a local battery to energize its transmitter, and uses a magneto generator to signal the central office. There were 837 common battery boards, or 7.7 per cent of the total number of switchboards, while the magneto boards aggregated 10,005, or 91.8 per cent; but the common battery boards, notwithstanding they were numerically much fewer than the magneto, are of greater importance. Common battery boards are used almost entirely in the larger cities, and hence are utilized by the bulk of the subscribers in the United States.

Statistics of switchboard equipment.—Tables 3, 5, and 6 contain statistics as to switchboard equipment. In the outlying districts there was a total of 14 boards, of which 12 were magneto and 2 were common battery. These systems had an average of 207 telephones per switchboard. For continental United States the number of switchboards reported as belonging to commercial systems was 9,954, or 91.4 per cent of the total number, while the mutual systems had 942 boards, or 8.6 per cent. All the private branch exchange boards, 7,883, were reported for the commercial systems.

When a comparison is made regarding the switchboard equipment of the Bell and the independent companies, as given in Table 6, it is seen that the Bell boards numbered 3,820, and formed only 35.1 per



CENTRAL AUTOMATIC EXCHANGE, GRAND RAPIDS, MICHIGAN, 6,000 LINE FULL AUTOMATIC.



MAIN EXCHANGE PITTSBURG, PENNSYLVANIA, BEFORE OCCUPANCY BY OPERATORS.

cent of the total number of boards; but there were 345 telephones per switchboard for the Bell companies, while the average for boards of independent companies was 141. The Bell system showed 7,266 private branch exchange boards, or 92.2 per cent, out of the total of 7,883, while on the independent lines there were only 617 such exchanges. In the Bell exchanges there were 356 common battery boards, or 9.3 per cent of the switchboard equipment of those exchanges. The independent common battery boards numbered 481, being 6.8 per cent of the total equipment of 7,076. Of the 54 automatic boards, the Bell companies operated only 1.

Geographic distribution of exchanges and switchboards.—Tables 8, 9, and 11 show the distribution of exchanges and switchboards by main geographic divisions. The North Central had the most exchanges, 5,212 for all systems—4,442 for the commercial and 770 for the mutual. The switchboards for this division were slightly in excess of the exchanges, numbering 5,500 for all systems—4,730 for the commercial and 770 for the mutual. Tables 46 and 47 give a detailed analysis, by states and territories, of the physical equipment of the 10,361 public exchanges.

In Tables 29 and 30 there is an analysis for states and territories, showing the average number of stations per switchboard for the commercial and mutual systems.

As shown in Table 47, the greatest number of common battery or central energy switchboards were in use in Pennsylvania, for which state 118, or 14.1 per cent of all boards of this class, were reported. The largest number of automatic switchboards was returned from Kansas, where 16, or 29.6 per cent of all automatic boards, were in use.

Table 40 shows, by states and territories, the distribution of the exchanges of the Bell and the independent companies.

TABLE 40.—*Number of public exchanges, Bell and independent systems, by states and territories: 1902.*

STATE OR TERRITORY.	Total.	Bell.	Independent.
United States	10,361	3,753	6,608
Alabama	69	31	38
Arizona	30	12	18
Arkansas	123	19	104
California	376	362	14
Colorado	96	80	16
Connecticut	44	40	4
Delaware	21	5	16
District of Columbia	5	5	....
Florida	38	8	30
Georgia	113	33	80
Idaho	33	28	5
Illinois	912	177	735
Indian Territory	50	....	50
Indiana	621	91	530
Iowa	710	68	642
Kansas	259	23	236
Kentucky	203	96	107
Louisiana	60	45	15
Maine	112	80	32
Maryland	88	24	64
Massachusetts	233	221	12
Michigan	511	185	326
Minnesota	246	23	223
Mississippi	95	64	31
Missouri	482	41	441
Montana	32	19	13
Nebraska	220	77	143
Nevada	11	8	3
New Hampshire	87	75	12
New Jersey	246	175	71
New Mexico	12	2	10
New York	713	408	305
North Carolina	125	7	118
North Dakota	49	4	45
Ohio	757	158	599
Oklahoma	52	4	48
Oregon	118	99	19
Pennsylvania	772	363	409
Rhode Island	20	18	2
South Carolina	82	15	67
South Dakota	103	9	94
Tennessee	158	95	63
Texas	334	118	216
Utah	22	22	....
Vermont	103	39	64
Virginia	139	14	125
Washington	140	135	5
West Virginia	180	27	153
Wisconsin	342	88	254
Wyoming	14	13	1

Indian Territory was the only civil division that had no Bell exchange and the District of Columbia and Utah were the only ones not represented among the independent exchanges. The largest number of the Bell exchanges, 408, was reported for New York state. The greatest number of exchanges of independent companies was shown for Illinois, which had 735 such exchanges.

Capacity of exchange and switchboard.—The total capacity of the switchboards was 2,447,403 lines, or an average of 225 for each board, as compared with an average of 200 subscribers, 212 telephones, and 445 miles of wire. The capacity of the switchboard is generally in excess of the actual demands of the service, but there is no essential relation between the capacity and the number of subscribers or telephones. There are many party lines and private branch exchanges having but one connection with the central switchboard, and in some sections of the country there are extensive toll lines operated without switchboards. On the other hand, in some states provision is made for accommodating independent farmer or rural lines, and the statistics for the stations of such lines are not included in the reports of the system to which they are connected.

Miscellaneous central office equipment.—The magneto office, rarely containing more than a few hundred subscribers, has little equipment beyond the distributing board, the switchboard with its primary cells for working the operators' transmitters, a ringing generator, and sometimes a prime mover to drive the generator and thus save labor on the part of the operators; but the modern common battery office of large size must contain a complicated and elaborate equipment consisting of a storage battery for supplying, it may be, many thousands of transmitters, a charging dynamo plant to replenish constantly the storage batteries, the necessary prime movers to actuate the dynamos, and a power switchboard, which for complexity sometimes rivals that of an electric light station, to handle the multiplicity of circuits that are needed for charging and operating the storage batteries. Moreover, proper relays and other racks are necessary to hold the auxiliary apparatus required by the common battery circuit.

Table 47 shows, by states and territories, the statistics relating to the equipment of the central offices. This table indicates that there was a total of 110,648 primary cells and 19,001 storage cells in use. Numerically the primary cells were much more important than the storage cells, since they corresponded to a larger number of magneto switchboards, but rated by the output of energy the storage cells far exceeded them. There were 196 engines, aggregating 2,750.5 horsepower, and 1,359 dynamos, aggregating 5,459.1 horsepower. The electric motors numbered 1,414, developing 4,209.8 horsepower. The greatest number of common battery boards which would utilize such power resources were found in Pennsylvania, where they numbered 118, while Ohio followed with 108. California, Mississippi, Nevada, New Mexico, Oregon, and Washington showed no common battery boards, but there was no state or territory that did not possess some magneto outfits. The largest number of boards, 861, was in Illinois, and the least, 11, in Nevada and New Mexico.

Method of central office connection.—The subscribers' circuits run either upon poles or in conduits to the central office and terminate there in a switchboard in a contrivance called a jack. Each jack consists of a set of springs to which the line wires are attached. These springs are supported on a strip of rubber hollowed out to receive and protect them. In front of each set a hole is drilled, the object of which is to guide a brass plug of proper shape to fit into the springs and cause it to make contact with them. By means of such a plug and the proper conductor attached thereto any subscriber's line may be extended outside of the jack. In addition to the jack each subscriber's line is provided with a signal, whereby he can attract the attention of the operator. In magneto switchboards this signal is called a drop, and consists of an electromagnet provided with a shutter normally held vertically by a catch attached to the armature. When the subscriber turns the crank of his magneto, the current over the line to the switchboard excites the drop, lifts the catch, and allows the shutter to fall, exposing the number. The jacks and drops are often associated in a single strip, so arranged that when the plug is inserted in the jack, it automatically restores the shutter to its first position. If the drop be permanently connected to the line, its presence impairs transmission, so that the springs of the jack are arranged in such a manner that the entrance of the plug cuts out the drop. The plug consists of a slender brass rod about three-sixteenths of an inch in diameter inserted in an insulating handle. The flexible cord is composed of a pair of stranded conductors carefully insulated from each other. The ends are inserted into the hollow handle of the plug and connected to its metallic parts. In addition there are three key switches, or three way switches. By means of one switch the operator can connect the telephone she wears upon her ear with the cord, and so receive the subscribers' orders. By the other switches the operator can ring the subscribers' bells.

A common form of switchboard key consists of a brass plate forming an escutcheon, which supports the key upon the shelf. Underneath there is an L-shaped piece of brass, to which are secured sets of springs that are attached to the line wires. The escutcheon plate carries a cam provided with a suitable handle and furnished with a rubber roller, which, when the handle is rotating, impinges upon the springs in such a manner as to lift one set of springs from the contacts which they normally make and moves them in such a manner as to make a new pair of contacts. This is a ringing key, which, when the operator releases the handle, springs back to its normal position and cuts off the ringing current. There is also a combined ringing and listening key arranged to ring when the handle is operated toward the right, and to switch the operator's telephone set onto the line when the handle is pressed toward the left. This key is automatic when used for ringing, but remains set when in the listening position. That the subscriber may notify the operator when conversation has been completed, a clearing-out signal, a high resistance drop, is bridged across the cord circuit. The essential features of the switchboard are the subscriber's terminal (jack and drop) and the cord circuit.

The complete switchboard.—A complete switchboard is formed by assembling as many sets of the apparatus described as may be necessary for the exchange. These are placed in a cabinet, shaped essentially as in Fig. 1 on plate facing page 46, and containing a vertical panel, in the upper part of which drops are placed. The lower section of the panel contains the jacks. Next comes the cord shelf with its cords and keys, the whole cabinet being so arranged that the shelf is of convenient height for the operator when in a sitting position with the drops and jacks arranged in front of her in such a manner as to be within the easiest possible reach. This illustration further shows the method of connecting lines by inserting a pair of plugs and cords into the jacks. The cords pass through holes cut in the shelf and are furnished with pulley weights whose

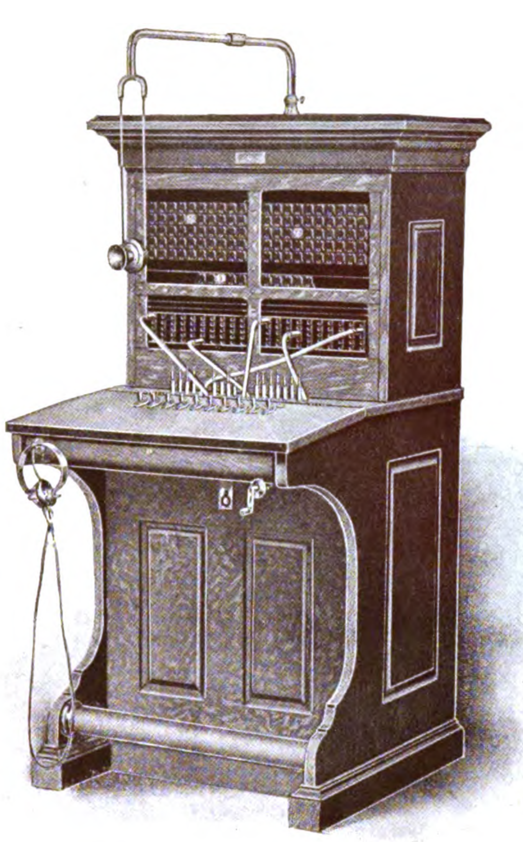


FIG. 1.—SMALL MAGNETO SWITCHBOARD.

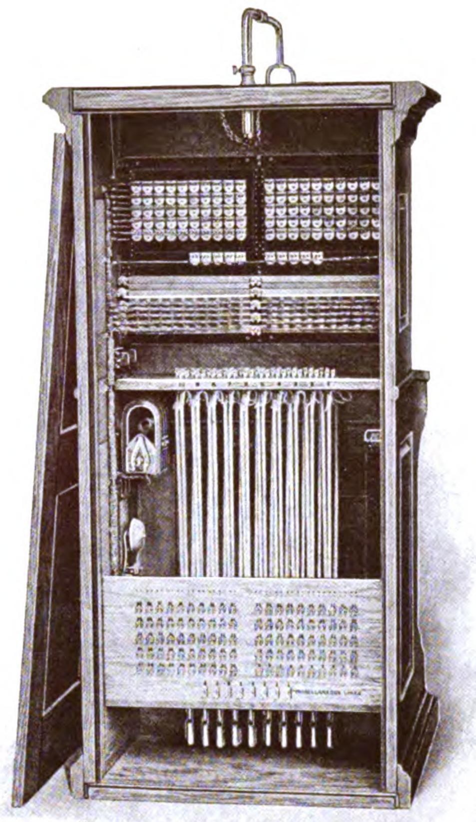
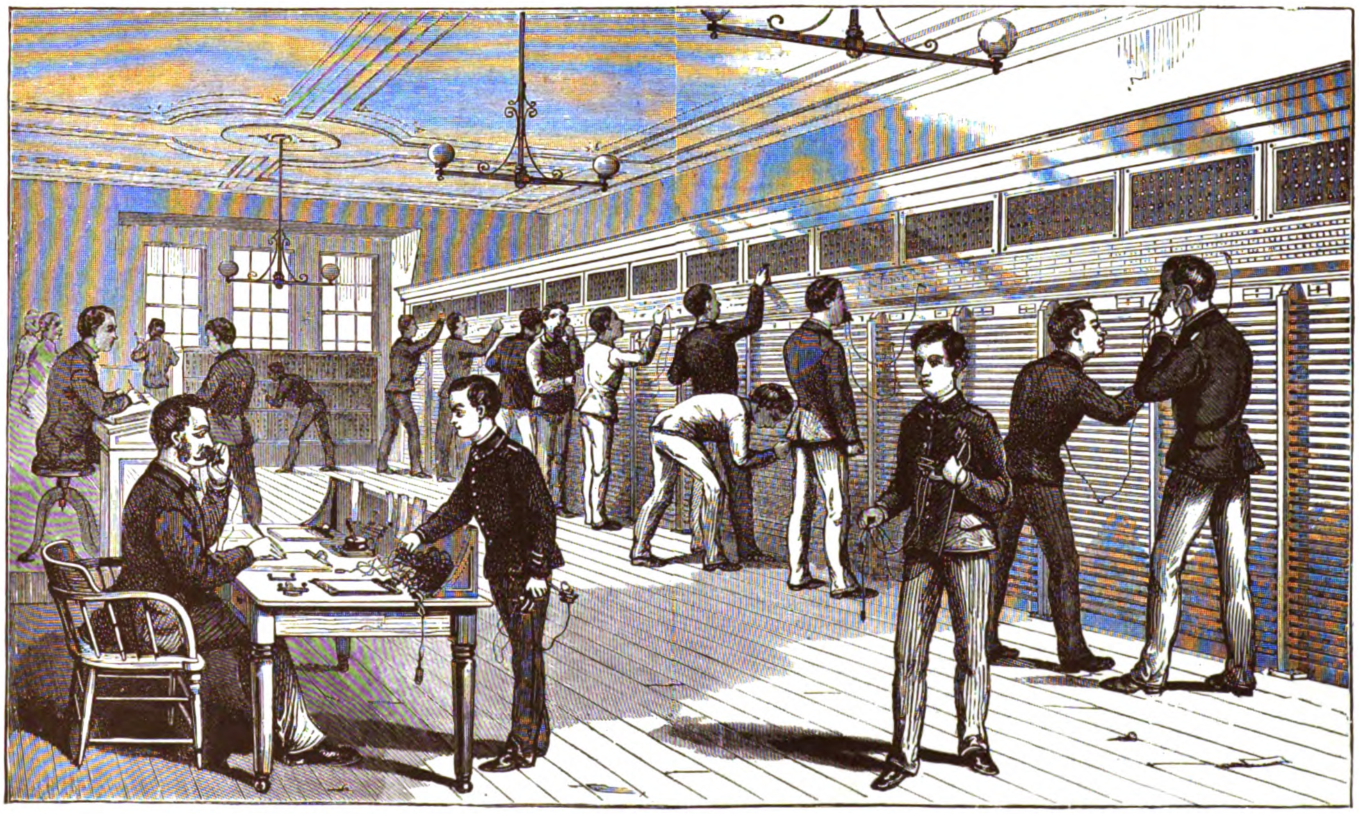


FIG. 2.—REAR VIEW OF MAGNETO SWITCHBOARD.



EARLY TELEPHONE EXCHANGE IN NEW YORK CITY.

function is to draw the cord back to its place as soon as the operator has removed it from the jack and thus keep the cord shelf free. A rear view, showing the apparatus contained, is given in Fig. 2 on plate facing page 46.

An operator can usually attend to about one hundred lines, and magneto boards are as a rule built in sections accommodating this number. As the number of subscribers increases, succeeding sections may be set up in proximity to each other, and, so long as the exchange is limited to three operators, each can reach the jacks of all subscribers, and hence can connect with all. When more than three operators are needed, it is impracticable for each operator to reach all the jacks. There are two solutions: One, the so-called transfer system, in which, if a subscriber calls for a party whose jack is out of the operator's reach, she may transfer the call to some other operator before whom the jack of the desired subscriber appears, by means of a local trunk line extending from her position to that of the other operator. The other method is known as the multiple switchboard. This involves equipping each subscriber's line with more than one jack, a sufficient number being provided so that a jack upon every line may be placed within the reach of every operator. As the operators are usually grouped in threes, this method requires at least one jack upon every line for every three operators. Then to complete a connection it is only necessary for the operator to find the jack of the subscriber to be called, insert the plug, and ring. There is a limit to this system, for, notwithstanding the expenditure of a vast amount of ingenuity, it has been found impracticable to make each of the jacks occupy less than one-fourth of an inch square, or even three-sixteenths, and, as the space available in front of the operator is limited by the length of her arms, it is impracticable to place more than 12,000 jacks in front of any three operators. A large multiple switchboard is presented in the illustration facing page 44.

Lamp signal switchboards.—As a signal the visual drop is found inefficient, because the operator often fails to notice the falling shutter, and also undesirable, because it occupies much space. It has now largely been replaced by the lamp signal, which consists of a miniature incandescent lamp, comprising a glass tube about one-fourth of an inch in diameter, shod with a wooden plug, carrying two brass strips that form the terminals. To hold the lamps in the switchboard, they are placed in a bank of jacks, resembling the subscribers' jacks, except that each lamp is furnished with a brass cap, upon which the number may be painted. The subscriber's line is furnished with a relay. The armature carries a platinum contact inserted in the circuit of the lamp. When the subscriber removes the receiver from the hook switch, current from the central office battery flows over the line, excites the relay, closes the lamp contact, and illuminates the lamp. The relays are mounted upon strips supported by a proper rack. As subscribers signal involuntarily by the removal of the receiver, and as the signals are operated by relays, the modern switchboard is variously called a common battery board, an automatic signal board, a lamp switchboard, a relay board, or a central energy board. Lamp signals are found equally efficacious as disconnect signals. For this purpose two lamps are used, one associated with each plug and placed in the cord shelf directly in line with the plugs. The circuit is such that each subscriber controls the lamp attached to the plug inserted in his jack. Hence each subscriber can always secure the attention of the operator.

The distributing board.—Before the subscribers' lines reach the switchboard it is customary to carry them through the distributing board or distributing frame. This is an iron framework, upon one side of which the subscribers' lines are terminated, and furnished with lightning protectors similar to those used at the substations. On the other side of the distributing board the switchboard cables end. The terminals on both sides of the distributing board are permanent, and the short connections between the sides are in the nature of temporary wires called jumpers. The object of this piece of apparatus is to provide for removals, and also to permit of equalizing the distribution of the "load" or work. A subscriber may change his location and yet desire to retain his telephone number. If the distributing board did not exist, it would be necessary to tear the switchboard cabling to pieces in order to run a new line to the old jack; but by means of the distributing frame a simple change with a jumper, which can be made in a few moments, suffices.

The common battery equipment.—Of all the apparatus of the common battery offices the storage battery is the most vital, for upon its integrity and continuity of service depends the success of every telephone in the entire exchange. The majority of common battery installations are operated at a potential of 24 volts, requiring a battery of 12 cells. In some cases a potential of 20 volts is used, and in a few others 36 or 40 volts. In some instances a duplicate battery is provided, while in others the office is so designed that the batteries may be charged concurrently without interrupting the regular services which they supply to the exchange. Usually the batteries are installed in a separate room, which is supplied with a concrete floor to avoid injury by acid and has an appropriate ventilating apparatus to dispose of the sulphuric acid fumes generated. The charging apparatus is of two classes. Where a commercial circuit is available, an electric motor is used to drive a dynamo which supplies the proper quantity and voltage of current to charge the storage batteries. In case no commercial circuit is available, some other prime mover—sometimes a steam engine, but more frequently a gas engine—is used to drive the dynamo. In addition, large offices must be supplied with power-driven ringing machines.

Common battery switchboard circuits.—The circuits employed in common battery switchboards are much more complex than those used in magneto installations. From time to time a great variety of such circuits have been produced, to describe which would require reference to numerous diagrams and would transcend both the space and the scope of the Census investigation into telephony. There are, however, certain basic functions which every such circuit must perform and which may be briefly indicated as germane to the general subject. Every common battery circuit aims to secure six results:

First. To make the calling and disconnect signals automatic and dependent solely on the position of the receiver at the substation; that is to say, the removal of the receiver transmits the calling signal, and its replacement the disconnect signal. As, without sensible error, it may be stated that common battery circuits are entirely metallic, the substation is so arranged that when the receiver is on the switch hook the circuit is open to the battery current, usually by means of a condenser, sometimes by arranging the calling circuit so that the exchange rings the subscriber overground; by this means, so long as the receiver is on the switch hook the subscriber may be called by means of an alternating generator current, but no battery current can flow.

Second. The provision at the central office of a common supply of electricity for all substation transmitters. This is usually accomplished by installing a single large storage battery. Some circuits, however, use two batteries so arranged that one becomes common to all calling subscribers and the other to all called subscribers.

Third. Such an arrangement of apparatus at the battery as shall cause each subscriber's line to be supplied with its proper quantity of current for talking, irrespective of differing resistances in the lines which may be coupled together; and further, such an arrangement of apparatus as will prevent the common battery from shunting or short circuiting telephone conversation. This is usually accomplished either by introducing a repeating coil between the coupled lines, or by joining the lines by means of a condenser and interposing between the battery and each cord conductor an impedance coil.

Fourth. Such an arrangement of signaling apparatus as provides a calling signal that is automatically removed by the insertion of the answering plug. This is accomplished either by the use of a cut-off relay that is actuated by the insertion of this plug, or else the plug shunts the line relay, or in some cases the use of jacks with multiple springs so arranged that the insertion of the plug opens the calling signal circuit.

Fifth. The provision of appropriate disconnect signals so arranged as to be inconspicuous during conversation, but becoming visible at the termination thereof. In some circuits this is accomplished by a relay which shunts the disconnect signal so long as the receiver is off the hook; in others, a relay makes a positive contact completing the disconnect signal circuit when the replacement of the receiver opens the subscriber's line.

Sixth. The provision of some method whereby a test shall be provided for all busy lines. This is accomplished in some circuits by means of a third wire which puts the battery upon the rings of all the jacks; in others, by a special relay, which when excited by the closure of the subscriber's line similarly charges the jack rings; and in others by such a combination of battery circuits as grounds the jack rings when the line is idle and insulates them and connects them with the battery when the lines are in use. To a skilled electrician it is evident that combinations for producing these results are numberless, and hence new ones are constantly arising.

Toll line switchboards.—A toll line switchboard does not differ materially from the local switchboards described, excepting so far as it may be necessary to adapt it particularly to the transaction of long distance work. The general course of toll business in important exchanges is somewhat as follows: For outgoing toll calls, a subscriber signals the operator in the usual manner; when the operator replies, the subscriber calls for the toll board, and the operator connects him with a so-called recording operator, who takes his order and makes a ticket memorandum of his name and number and the city and address of the party he desires to reach. The recording operator tells the calling subscriber that he will be called as soon as the party can be secured. The recording operator then passes the ticket to the proper toll line operator, who secures a toll line to the town specified and calls the party to the telephone. The toll line operator, by a trunk line, connects the toll line to a special operator at the switchboard, to whom the handling of toll work is delegated. This operator calls the original subscriber and connects him to the trunk line extending to the toll board.

An incoming toll call is simpler, as it is unnecessary to make a ticket. When an incoming call reaches the toll operator, she connects herself, by means of an order wire, with the special toll operator at the local board and instructs this toll operator to obtain the desired subscriber and to connect him by a trunk line with the waiting toll party.

ONE WING OF TELEPHONE EXCHANGE, CORTLANDT STREET, NEW YORK CITY, WITH OPERATORS AT POSITIONS.

CHAPTER IX.

EMPLOYEES, SALARIES, AND WAGES.

General statistics.—The rapid growth of the telephone industry between the years 1880 and 1902 is nowhere better exemplified than in the increase in the number of employees connected with it, although, as a matter of fact, the number per exchange in 1902 would indicate a falling off in the ratio for each plant. In 1880 the number of employees was returned as 3,338, whereas in 1902 the number of salaried officials, clerks, etc., and wage-earners was 78,752, or almost twenty-four times as great. But while at the beginning of real development, in 1880, the number of employees per exchange was about ten, it had fallen in 1902 to between seven and eight, due to the great improvement in apparatus. These conditions were due undoubtedly to the springing up of independent systems during recent years, calling into existence a large number of small exchanges in places of minor population. In view of the rapid rate at which the industry is still developing, it might be assumed that as the exchanges grow in number of subscribers and conversations they will need more operators, restoring the old ratio and going beyond it, especially as the multiple switchboards have apparently reached the limit to which connecting devices can be concentrated in front of any one operator or group of operators. Offsetting this, however, is the recent development of the automatic exchanges, some of which are planned on a scale of great magnitude, and tend to minimize the use of human hands and eyes in establishing connection and furnishing service.

While women have found a limited employment in telegraphy, the art in this country has remained practically in the hands of men. On the other hand, telephony, with its simpler, narrower range of work to be performed at the central office, has provided opportunity for a large number of young girls at a low rate of pay, comparing in this respect with the factory system. The duties performed in a telephone exchange are, however, much more varied than those connected with watching mere machinery, as behind each telephone instrument lies the varying personality of the subscribers, and in addition to this the large exchanges, by their short hours and agreeable surroundings, have made the employment inviting to many young women of education whom the wages would not otherwise attract. Moreover, opportunities of preferment are offered not only in the exchange, but outside, owing to the evolution during late years of the private branch exchange, which serves as a means of intercommunication in large offices and other places, while connecting also with the exterior public through a miniature multiple switchboard. Positions in these private exchanges at advanced wages have become so numerous that in New York city at the time of this report there were more operators thus employed than were to be found in all the great exchanges of the local telephone company. These private exchange operators are not brought to account in the present statistics, because they are not carried on the pay rolls of the telephone exchange systems from which they might be said to graduate. But they are obviously a part of the great army of telephone employees, enabling the art to be carried on, and in any statistics of operation they would naturally and properly be enumerated as telephone employees. It might be incidentally noted that in a similar manner the private telegraph operators, a numerous body, were not included in Table 1 of Part II, and that in some instances a male operator will be found serving both at the key and at the telephone switchboard. All such private exchange switchboards are, however, attended to by the inspectors, linemen, troublemen, etc., enumerated in Table 45, the upkeep of such boards being a small part of the annual contract between the subscriber and the local telephone company.

Statistics of employees and wages for all systems.—Table 45 presents, by states and territories, detailed statistics of employees and wages for all systems. The aim of the inquiry concerning the number of wage-earners was to ascertain the number required, under normal conditions, to carry on the work of the different systems, including all branches of the service. Accordingly the average number employed during the entire year was called for, but a number of the commercial companies reported that some wage-earners were engaged for only a portion of the time each day.

The average number reported for all commercial and mutual systems, including the salaried officials, superintendents, clerks, operators, and wage-earners required on the line, and other equipment, was 78,752. Practically all of these were employed by the commercial companies, as shown also in Table 9. A large number of the mutual companies reported that the service was not sufficient to give constant employment to anyone, practically all of the repair work being done by the patrons.

Of the total number, 14,124, or 17.9 per cent, were salaried officials, general superintendents, and clerks, and 64,628, or 82.1 per cent, were wage-earners. The salaries and wages paid during the entire year amounted to $36,255,621, of which the salaries formed $9,885,886, or 27.3 per cent, and the wages, $26,369,735, or 72.7 per cent.

In many instances one employee—reported sometimes as an exchange manager, sometimes as a lineman—was engaged at a specified annual compensation to care for an entire exchange, keep the line in repair, and perform all duties incident to its operation. In such cases no operators were reported, as members of the family of the employee attended to the switchboard. This practice was followed in many mutual systems, and was in use also in some small commercial companies. In the smaller systems the same employee performed the duties of a foreman, inspector, lineman, wireman, batteryman, and troubleman—in fact, attended to the entire plant; therefore the segregation of employees by classes presented in Table 45 can not be accepted as showing the exact average number required for each class.

It should also be noted that of the operators no fewer than 37,333 were women and only 2,525 were men, the former receiving $10,035,432 in wages and the latter $729,666. It is evident, therefore, that these women operators in the exchanges constituted more than half the total average number of wage-earners in the whole industry. The moderate rate of their pay can be inferred from the total sum credited to them as wages. A slight difference as to income is shown in favor of men operators, but this might well be due to the fact that in many exchanges the night work, justifying a higher rate, is performed by the men.

Statistics for principal states.—A study of the statistics by states and territories shows that the number of employees and their salaries and wages follow in due proportion the figures as to income and expenses and also throws light on the size of the exchange systems. Thus the 4,151 systems reporting had 14,124 salaried officials, clerks, etc., and 64,628 wage-earners, an average of 3.4 and 15.6, respectively. From these averages there were wide variations. Thus Massachusetts, with 10 systems, reported 1,155 officials, or an average of 115.5, and 3,524 wage-earners, or an average of 352.4. In Iowa, however, the 411 systems had only 341 salaried officials, clerks, etc., and 1,909 wage-earners, revealing the presence of a number of very small systems in which the operator would suffice for most executive functions.

New York state had the largest telephone force, namely, 2,318 salaried officials, clerks, etc., and 7,765 wage-earners, attached to 267 systems, or, respectively, about 9 and 29 per system. Next came Pennsylvania, with 1,475 and 6,682, closely followed by Illinois, with 1,415 and 6,066. While Pennsylvania had only 97 systems, Illinois had no fewer than 381, and thus showed much less concentration of executive duties. Ohio, with 285 systems, had 809 salaried officials, clerks, etc., and 5,469 wage-earners, showing that much still remained to be done with regard to unification or centralization of management. The same is true of Indiana, with 366 systems, 476 salaried officials, clerks, etc., and 2,860 wage-earners.

Such figures as those for Iowa, Ohio, and Indiana, centers of the independent movement, bring out clearly the extent to which exchanges still stood separate and alone, and this condition is brought out even more clearly by reference to Table 6, which summarizes the statistics of the Bell and the independent systems. For the vast Bell network there were only 44 systems, with 10,341 salaried officials, clerks, etc., and 46,064 wage-earners, or 235 and 1,047, respectively, per system. As compared with this, the 4,107 independent systems had 3,783 salaried officials, clerks, etc., and 18,564 wage-earners, or an average per system of less than 1 official and 4.5 wage-earners.

Statistics of commercial systems.—The 3,157 commercial systems reported the great majority of salaried officials, clerks, etc., and wage-earners, employing of the former class, as shown in Table 9, no fewer than 13,958 out of the 14,124 and of the latter 63,630 out of a total of 64,628. To these employees $9,871,596 was paid in salaries and $26,206,065 in wages. The distribution of these numbers and amounts followed so closely that for all systems as to need no further analysis or discussion.

Statistics of mutual systems.—There were reported 994 mutual systems. Such systems are not, in principle, operated for revenue, and as a general thing require very few paid officials or wage-earners of any kind. It appears, however, that in 1902 the 994 systems enumerated had 166 salaried officials, clerks, etc., drawing $14,290 in salaries, and 998 wage-earners, receiving $163,670. In only 30 states and territories were the figures large enough to be tabulated separately, and over half of the systems were reported from 4 states—Iowa, with 170; Illinois, with 138; Indiana, with 105; and Missouri, with 90. These 4 states had 92 of the salaried officials, clerks, etc., and 648 of the wage-earners. The largest number of wage-earners in any state (184) was in Iowa, but that state had only 9 of the salaried officials, clerks, etc.

The welfare of telephone operators.—For many years it has been recognized that operators' work in telephone exchanges attracts a superior class of women. It has been demonstrated beyond all doubt that the work of operating is better handled by women than by men or boys and that trained and well-bred women operators perform the most satisfactory service. This has resulted in gathering into the exchanges throughout the country young women above the average in ability and ambition. From an early day the telephone companies in the United States have been alive to the importance of securing and retaining this quality of labor, and have appreciated the desirability of providing something more than the required salaries in the way of generally looking out for the welfare of their operators.

As long as twenty years ago it was generally the practice in exchanges in large cities to provide comfortable rest and retiring rooms, and some portions of a luncheon, properly supervised by a matron in charge. Latterly, in many exchanges, the companies have undertaken to furnish the entire lunch and to sell it at cost to the operators, while in at least two of the larger cities the companies have for several years been furnishing the lunch entirely at their own cost. The effect on a large working force of providing ample cloakroom facilities, with well-ventilated lockers, good rest and reading rooms, and a hearty meal has been apparent in the better health of the operators employed.

Some three or four years ago, and continuing since, in one large local system an effort was made to go somewhat beyond these matters of physical comfort and to endeavor to secure the interest of the operators throughout the force, not only in their work in hand, but in some one or more matters of interest outside of the actual work they perform for the company. In this exchange a lecturer was at one time employed to deliver addresses on accuracy and on the general development of accurate methods. This was followed by furnishing scrapbooks, in addition to the other reading matter regularly furnished, containing material having a special bearing on accuracy and general improvement. Then opportunity was given in each exchange for operators to make up scrapbooks themselves, and upon a competitive basis the best two were to receive appropriate prizes. The books thus compiled were of unusual interest and indicated no inconsiderable talent throughout the force. When the prizes, which were money, were awarded, it was determined by a vote of the operators of the respective exchanges that the sums be invested in books and that libraries be established. The company responded by furnishing accommodations for libraries, and by an offer not only thus to provide for the two exchanges in question but to duplicate in other exchanges any amounts which might be subscribed for library purposes. The result has been to establish excellent circulating libraries in eleven of the fourteen city exchanges, so arranged that each of the three remaining exchanges is a branch of the public library in the city, where books are regularly delivered. In a number of exchanges reading clubs have been established. In others, where opportunity offers, each year a garden is established and maintained and interest is shown by the operators in assisting to plant and care not only for the flower garden but in one or two instances for vegetable gardens, the crops of which are enjoyed throughout the summer season.

In one local system a scheme of rating has been established, based upon a number of service tests which are made each month, and from which is determined the relative standing of each of the fourteen offices. Each month those ranking first and second in the list are given prizes, usually in the form of pictures, each of which is duly inscribed as a prize for the work, and at the same time some book or pamphlet giving information concerning the painting or artist is distributed.

In one exchange support has been given to a women's athletic club in the neighborhood, and classes for evening instruction in the gymnasium have been joined by a considerable number of the operators.

Recently a plan has been carried out whereby the force of operators is recruited by the efforts of those already in the company's employ, and a premium in money is given for each applicant recommended who remains in the operating training school a period of two weeks. An additional sum is paid when the applicant has graduated and has remained on the operating force for a period of three months. The general desire has been to give to the operator who may be so inclined an opportunity to join in the work of self-betterment and to think and work along the lines followed by operators who may be about her. The results seem to show that such a community of interest may be established and maintained with desirable results.

In the training schools for operators applicants are examined with care to determine whether they are likely to develop the high standard of efficiency required throughout the force, part of the examination being made by a qualified physician.

To an intelligent person there are few branches of work that are of more continued interest than telephone operating. The handling of each call presents something new in itself. It may almost be said that no two operations are exactly alike, and the guiding hand that makes possible the thousands or even millions of combinations of lines has a most interesting task to perform. This continual feature of interest relieves the work from all drudgery and attracts to it a high grade of intelligence. Welfare work among such a class of employees, therefore, is not only a grateful task but one that is appreciated to an unusual extent.

CHAPTER X.

DEVELOPMENT OF THE MESSAGE RATE PLAN IN NEW YORK CITY.[1]

Although Alexander Graham Bell's invention, the speaking telephone, was introduced to the world at the Centennial Exhibition in Philadelphia in 1876, it was not until 1878 that a telephone exchange was established and opened to the public for general service. It has been well said by one identified closely from the very beginning with the remarkable development of the telephone in all its varied applications and uses that "while it is the telephone that has made the telephone exchange possible, it is the exchange that has made the telephone indispensable."

To gain a true idea of what is meant by telephone service in a great city, it should be borne in mind that such service involves the use of a complex physical plant made up of numerous and expensive parts distributed over a wide area, and the performance of labor by an army of people, each highly skilled in some particular branch of the work.

From time to time radical changes in conditions have taken place, and these have controlled the evolution of the rate plan. In considering the rates in force at any given time the then existing conditions must be clearly borne in mind.

In the early days it was the custom to charge a fixed annual rental per telephone, regardless of the amount of service to be rendered the subscriber; that is, regardless of the additional labor and of the additional plant which might be required in other parts of the system, growing out of the increasing use which the subscriber might make of his telephone. This method of charging is now known as the "flat rate" system. That it should have been adopted by the pioneers in the telephone industry is not surprising, for during the first stages of development the telephone exchange served but a small number of subscribers in a restricted area, the vast and complicated and expensive provision of lines and equipment which are to-day necessary to handle the traffic of a great city was not then required, and within reasonable limits there was substantial uniformity in the use of the service by the various subscribers. Even to-day, where the telephone exchange consists of one central office and where the stations to be served are numbered by hundreds rather than thousands, the flat rate method of charging is found to apply with few exceptions. To meet the conditions surrounding the operation of the first telephone exchange in great cities, the flat rate may be said to have been reasonable and best calculated to develop the industry.

Early service and rates.—For several years following 1878, when the work of conducting a telephone exchange as a commercial undertaking was begun in New York city, the telephone exchange system was confined to the lower end of Manhattan Island. The area actually covered was small. The limited number of correspondents which it was possible for one to reach restricted the use of the telephone, and, moreover, measured by later standards, the service was slow and performed cheaply.

At the beginning, and for some sixteen years after, the flat rate system was the only method of charging for the service, but the rates were not wholly without classification. Lower rates were available at residences than at business places; the charge was higher to a subscriber who required the exclusive use of the wire which connected his telephone to the central office than to one who shared the use of the wire with one or more other subscribers; subscribers remote from the central office paid extra charges, varying with the length of wire required, and when a double wire, or "metallic circuit," was required, an additional charge was imposed. Thus there was a scale of graduated charges, varying with the character of the facilities provided, the length of line required, and the amount of service rendered, so far as that was determined, so to speak, by the potentiality of the telephone; that is, whether it was at a residence or a place of business.

With an expanding area over which exchange telephone service must be rendered, and a consequent increase in the average length of line, affecting both investment and working expense, and with an increasing volume of traffic per station, due to the constantly enlarging potentiality of each telephone through the addition of new subscribers, the costs per telephone were found to increase. In consequence the rate for a business telephone on a direct or individual line, which at the outset was $60 per year, was advanced until it reached $150 per year. The residence rate was two-thirds of the business rate, and a discount

[1] Prepared from data supplied by Mr. U. N. Bethell, vice president and general manager of the New York Telephone Company.

of 25 per cent was allowed to the subscriber having telephones at both his place of business and his residence.

Metallic circuit introduced.—In 1887 the New York Telephone Company, or more properly the Metropolitan Telephone and Telegraph Company, the company then operating the system in New York city, began to introduce the "metallic circuit" system. This marked an epoch in the development of the telephone in America. Prior to this time, and following the practice of the telegraph companies, the telephone line, whether extending between two telephone offices or from the telephone office to the subscriber's station, consisted of one wire which, after passing through the instrument at each end, connected with the ground, which served the purpose of a return circuit. It was found that when a number of these single wires were strung together upon poles for any substantial distance, and even though separated by distances as great as a foot or more, conversation taking place upon one wire could plainly be heard upon those in the neighborhood. This was found to be true even if the wires were insulated in the highest degree known to the art. Also the operation of electric railroad and electric light circuits produced in the single wire telephone system buzzing noises, which at times rendered conversation well-nigh impossible.

After years of experimentation and the expenditure of large sums of money, it was found that these difficulties could not be overcome without the use of a second wire for each circuit. It was also found that this second wire must be run in a special relation to the first wire, and that both of the wires constituting a given circuit must be placed in predetermined relation to the neighboring circuits.

The introduction of the metallic circuit system meant not only the complete reconstruction of the entire line plant, both overhead and underground, but also the replacement of all the central office switchboards with apparatus designed to meet the new conditions as well as the substitution of the now well-known "long distance" telephone in place of the old type at all subscribers' premises. In June, 1889, when this work was in progress, there were about 8,000 telephone stations in the old New York city, served by five central offices, located, respectively, in Cortlandt street, Spring street, Eighteenth street, Thirty-eighth street, and One hundred and twenty-fifth street. All of these offices were in the present borough of Manhattan. There was then no central office in the whole of the great area now known as the borough of the Bronx. The population of New York, which at that time included that portion of the metropolitan territory now known as Manhattan and most of the present borough of the Bronx, was about 1,200,000, and the ratio of stations to population about 1 to 150. During the following five years practically the entire system was changed to the metallic circuit basis, and there was a moderate increase in the number of telephones, making the total on June 1, 1894, 11,054, or about 1 to every 136 of the population, then approximately 1,500,000. During these five years four additional central offices were opened in Manhattan—at Broad street, Franklin street, Columbus avenue, and Seventy-ninth street—and a very small office known as Tremont was opened in the district now known as the Bronx. Prior to the opening of the Tremont office telephones located in the Bronx were connected with the Harlem exchange on One hundred and twenty-fifth street.

The greater investment and the greater cost of maintaining the new and greatly improved system necessitated a readjustment of rates. The flat rate principle was adhered to and rates were fixed as follows:

Business, direct line	$240 per year.
Business, two-party line	150 per year.
Residence, direct line	180 per year.
Residence, two-party line	125 per year.

First message rates.—By 1894 the reconstruction on a metallic circuit basis was practically completed; 76 per cent of the subscribers had taken the improved service and it was felt that the changing of the remainder was only a matter of time. The plant being in excellent condition and the facilities greatly increased, attention was directed to extending the use of the service by securing new subscribers. It was evident that in order to accomplish this a new rate schedule must be adopted involving new methods of charging for the service. A plan by which the number of messages to be sent should be taken as the basis of the rate was seriously considered. As early as 1888 a commission of the legislature of the state of New York, commonly known as the Ainsworth committee, after investigating telephone conditions throughout the state, commended the message rate plan as fair and equitable and as having many marked advantages to both customer and company over the flat rate. In the early eighties a message rate system was introduced in Buffalo, where it is still in force, and in one or two other localities early experiments were made with message rates, but New York was of such size and physical conformation that the experience of these other places furnished no adequate basis upon which to deal with the complexities of the problem. Finally, after the most careful consideration, it was decided to introduce the message rate plan tentatively in the endeavor to bring telephone service within the reach of the small user, and also to give relief to subscribers who, although their use was small, were paying the same rate as that at which service was furnished to large users.

The first message rate schedule was put into effect on June 1, 1894. Under this schedule the minimum rate for direct line service was $150 for 1,000 local messages. The rate for 1,200 messages was $166 and for 2,400 messages, $240. For an extension station located on the premises where the original station was installed the charge was made $24, as against $36 under the flat rate schedule, all messages to be considered as though sent from the main station. For a party line service the new schedule provided a minimum rate of $100 for not more than 700 local messages. In this first Manhattan schedule a "local message" was a message to any point on Manhattan Island south of One hundred and tenth street. This was soon modified to include the present local area, that is, the whole of Manhattan Island, constituting, as it does, the entire borough of that name. The old flat rate of $240, with a rate of $36 for an extension station, was continued for those who preferred it to the message rate plan, but as a matter of fact a great many subscribers gave up their old contracts when they found that they could get their service at less cost under the new schedule.

The five years from June 1, 1894, to June 1, 1899, constituted what might be called the experimental period for the message rate, as during these years the message rate plan was given its first real test in a large city. Theoretically the message rate principle seemed sound and the idea of charging according to use fair and reasonable, but it had never been applied to an extent which would form any precedent for New York, and it was necessary to feel the way, changing and modifying the schedules as warranted by experience.

Features of message rate plan.—At this point it may be well to mention a few of the features of the message rate plan in New York city that have persisted with slight changes, through the various schedules, from those first adopted up to the present time. The rates are based on a sliding scale, according to the number of messages which the subscriber estimates he will send in a year. Provision is made in all contracts for a refund to the subscriber when the number of messages sent by him in the year has been less than the number for which he has paid. The adjustment is made by charging the subscriber at the schedule rate for the actual number used, not less in any case than the minimum rate for the class of service involved, and rebating the difference between that amount and the amount which he has already paid. In several schedules slightly lower rates at certain points in the schedule were offered the subscriber on his agreeing to waive any rebate for unused messages, but this special plan never became popular and was soon abandoned. Early schedules provided for quarterly payments in advance, but this plan was ultimately superseded by one providing for monthly payments. The yearly settlement idea has always been followed—that is to say, adjustments with subscribers have been based on the number of messages sent during the contract year, without regard to the distribution of the usage between the several months.

Reductions in message rate schedules.—It was for the benefit of the small user that the June 1, 1894, schedule was adopted. In the following November a direct line rate of $120 for 700 local messages was introduced, with a party line rate of $80 for 500 messages. In March, 1895, the number of messages at the $120 rate was increased from 700 to 1,000, the rate for 1,200 messages decreased from $166 to $132, and the rate for 2,400 messages from $240 to $195.

On May 1, 1895, rates of $90 for 600 local messages on a direct line and $75 for 600 local messages on a two-party line were adopted. Following the adoption of these schedules the number of stations increased rapidly.

On July 1, 1897, further changes were made at various points in the schedule, but the minimum rate for direct line service stood at $90 until April 20, 1899. On that date new business schedules were adopted, beginning at $75 for 600 messages and ending at $228 for 4,500 messages on a direct line; and beginning at $60 for 600 messages and ending at $135 for 1,800 messages on a two-party line. Under these schedules the rate for an extension station was reduced from $24 to $12 per year, both on business and residence lines. No extension stations, however, were installed in connection with party lines. These schedules remained in force until May 1, 1905.

During the first five years of the message rate period—that is to say, from June 1, 1894, to June 1, 1899—the number of stations in Manhattan and the Bronx, which territory is practically identical with the old New York, had increased to 31,241, a gain for the period of 21,176. The population in the meantime had increased to about 2,000,000, making the ratio of telephones to population 1 to 64, as against 1 to 136 at the time the message rate was introduced.

There was a gain of nearly 200 per cent in the number of telephone stations during the first five years after the message rate plan was adopted, and at the end of that time only 10 per cent of the total number of telephones in service were on a flat rate basis. The growth of the system since 1899 has been even more rapid, as will be seen by tables on page 60, and the percentage of flat rate stations has continuously decreased, until now it is quite insignificant.

Rates in local areas—borough of the Bronx.—In working out the problem of adapting the charges for telephone service, and the service itself, to the means and requirements of the various users in particular localities, it was early recognized that a community which has a fairly self-contained business and social life can best be served by a local rate covering service within the locality, even though the community politically be part of a larger civic organization. With this in view, a separate local schedule for the territory north of One hundred and thirty-eighth street was adopted in June, 1895. By this schedule local rates of $65 for 500 messages over a direct line, $50 for 500 messages over a two-party line, and $40 for 500 messages over a three-party line, were introduced.

When Greater New York was formed, on January 1, 1898, and the territory north of the Harlem river was made the borough of the Bronx, a schedule of local Bronx rates was put in force, beginning at $50 for 500 messages on a direct line, and $40 for 500 messages on a two-party line. Later, on May 1, 1899, these rates were changed to $48 for 500 messages over a direct line, and to $39 for 500 messages over a two-party line. For the benefit of those who desired service over both boroughs—Manhattan and the Bronx—a two-borough rate was offered at $90 for 600 messages over a direct line. There was very little demand for this service, however, and it was subsequently withdrawn.

With the development of the Bronx borough, other rates were adopted, one being $30 per year for 400 messages to any part of the Bronx. With the rapid growth of this territory and its division into 5 central office districts, rates were offered for local service within each of the exchange districts.

Residence rates.—At the outset all message rate schedules applied alike to business places and residences. In November, 1901, a separate schedule was adopted for service at residences, physicians' and nurses' offices, and private stables. The schedule began with the minimum rate of $66 for 600 messages on a direct line, or $9 less than the business rate, and $48 for 500 messages on a party line. It was felt that the more general distribution of the traffic from residence stations throughout the twenty-four hours, and the comparative freedom of this class of traffic from the liability to the violent fluctuations in volume characteristic of the service in purely business districts, justified this concession. This principle was adhered to in formulating later schedules.

Private branch exchange service and rates.—The growth of the telephone system in New York city has been due largely to the development of "private branch exchanges." Such an exchange consists of a central office switchboard located on the subscriber's premises, into which are brought the lines from the central office of the telephone company, as well as those connected to telephones in the various offices and departments of the establishment.

The telephone user abhors the "busy" line, but before the perfection of the private branch exchange this was the chronic condition of the line, or lines, of many large users. Under the flat rate system, when a subscriber was convinced that one line was not sufficient to handle his traffic, a second line was put in, and in some instances a third, but a mere multiplication of lines offered only a partial remedy.

If a large concern had three lines, they were apt to be distributed among different departments and in locations on the premises widely separated. If the manager was wanted, and his line on the first floor was "busy," a call was sent over one of the other lines and that, of course, necessitated the sending of a messenger for the person called, who in responding was required to make a trip to another part of the building. This system was clumsy, dilatory, and unsatisfactory. It squandered the time of the subscriber and of his employee, and it was equally wasteful of the time of the employees of the telephone company.

The need for a method of telephone service by which incoming and outgoing messages could be handled simultaneously in large numbers, and by which at the same time the various departments or rooms of large establishments could be given an intercommunicating telephone service, brought about the development of the private branch exchange telephone system.

In recent years the private branch exchange has come into such general use that it needs no extended description. At first confined to the large offices downtown, as time went on its utility in any large establishment became so apparent that it has grown to be the standard method of furnishing telephone service where the amount of telephone traffic to be handled is beyond the capacity of a single circuit.

At the time of the introduction of the message rate plan in New York city, private branch exchange service was also passing through its experimental period, and on July 1, 1894, this service was offered to the public on a message rate basis. The schedule began at a minimum rate of $333, which included the installation of a local switchboard, two central office lines, two telephones, and 4,000 messages in a year. Additional lines to the central office were at the rate of $36 a year each, and additional telephones connected to the subscriber's switchboard, $24 a year each. Local messages above the first 4,000, if contracted for in advance, were charged for at the rate of 3 cents each; if not contracted for in advance, the rate was 5 cents each.

On May 1, 1898, the rate for telephones connected to the subscriber's switchboard was reduced to $12 per annum. On May 1, 1901, the minimum rate was reduced to $240, covering, as before, the equipment of a switchboard, two lines, and two telephones, but with a reduction in the minimum number of messages from 4,000 to 3,600. The rate per message over the 3,600, when contracted for in advance, remained at 3 cents, but the 5-cent rate for messages not contracted for in advance was reduced to 4 cents.

On June 1, 1905, there were in use 6,637 private branch exchanges in Manhattan and the Bronx alone, with 17,704 central office lines, furnishing service for 67,076 stations. Since that date the number of telephones served by private branch exchanges has grown to over 70,000. The installations vary from the small switchboard, with two lines to the central office and two telephones on the subscriber's premises, to large systems, such as that of the Waldorf-Astoria, with its 1,200 telephones, which would be a fair installation for many a small city. Large concerns having offices in various parts of the city have unified their systems by connecting, by means of "tie lines," the switchboards located in each of their various establishments.

Without the message rate schedule this private branch exchange development would have been impossible. Private branch exchanges are installed under different conditions in nearly every instance. In one system, where the service is used more for interior intercommunicating purposes than for general exchange purposes, there may be a demand for a large amount of equipment with a proportionately small amount of traffic. In another instance, although the equipment may be limited, the number of messages actually sent and received may run into the hundreds of thousands.

It is readily seen that a flat rate plan would not be flexible enough to cover adequately the widely fluctuating conditions which obtain in the application of the private branch exchange service that has contributed so largely to the rapid and great development of the telephone business in New York city.

Pay stations.—With the adoption of the message rate schedule, in 1894, and the effort to place its service within the reach of everyone desiring to use it, provision was made for the convenience of the casual user. "Pay stations,"as they are commonly called, were installed in great numbers, the object being to cover the field in an adequate manner. No guarantee was required on the part of the subscriber other than that the receipts, less a commission, be remitted monthly to the company.

Message rate subscribers were also encouraged to allow a public use of their telephones, and pay station signs were furnished to these subscribers. There are now in service in Manhattan and the Bronx over 13,000 public stations displaying pay station signs. So thickly are they dotted over Manhattan Island that wherever one finds himself it is only necessary to take a few steps in order to reach a public telephone. It is needless to say that this service has been of the utmost benefit to the public at large, and it is one of the features of the telephone system of New York which is very generally appreciated.

At the railroad stations and hotels and in the corridors of large office buildings where the managers or proprietors do not arrange for sufficient telephone equipment to cater satisfactori y to the public at large the service has been supplied by the company itself in a very liberal way. Space has been rented, and the latest and best equipment, with small switchboards, sound-proof booths, etc., has been installed, and competent attendants are placed in charge.

In the early days the charge for a local message within the borough of Manhattan at a pay station was 15 cents, but in June, 1898, the rate was reduced to 10 cents.

Rates in Brooklyn, Queens, and Richmond boroughs.—Preceding paragraphs have dealt with the rates and conditions in the boroughs of Manhattan and the Bronx, the territory operated by the New York Telephone Company. The telephone systems of the boroughs of Brooklyn, Queens, and Richmond, which comprise the territory brought into New York city, or Greater New York, by the consolidation on January 1, 1898, have always been and still are operated by the New York and New Jersey Telephone Company.

In the urban portion of the borough of Brooklyn (the old city of Brooklyn) the introduction of the message rate came at the same time as in the boroughs of Manhattan and the Bronx, and the subsequent development of the rates has been practically identical with that in old New York. The borough of Richmond and certain portions of other boroughs differ widely in character from the areas in which message rates were introduced. Although a part of Greater New York, certain sections are far removed from the active business center and development has been principally of a residential nature. Before the territory came into Greater New York each of the small communities scattered throughout the city had its own political as well as social life. In these small places local flat rates were in force. Although these communities have grown in population and importance and have become part of a larger political organization, their interests remain largely local. As these communities are not large, as the telephone development has been principally in the direction of residence service, and as in each of them a small exchange is able to handle the traffic adequately, the flat rates have persisted, and with a few exceptions are in force to-day. The rates in these communities vary with the local conditions, and although based on the flat rate principle, they are adjusted as far as possible to meet the requirements of the user, separate schedules being in force for residence and for business service, and party line service being furnished at a considerably lower rate than that charged for a direct line service.

In ten years the telephone development in the boroughs of Brooklyn, Queens, and Richmond has increased over 600 per cent, the greater part of this growth occurring in the urban territory of Brooklyn. Under the present message rate, service is furnished in this borough at $54 a year for direct line business service and $42 for party line business service. Residence service is furnished at $51 for a direct line, with a party line rate of $36, the number of messages at the minimum rate in each instance being 600. In this borough flat rates for residence service are also offered. The flat rates already mentioned as in effect in the small localities are in most cases $48 for direct line business service, $36 for direct line residence service, $36 for business party line service, and $24 for residence party line service.

Present conditions and growth since adoption of message rate.—When, on June 1, 1894, the message rate was introduced, the New York Telephone Company had in its territory, which is practically identical with what is now known as Manhattan and the Bronx, 11,054 telephone stations in operation. The New York and New Jersey Telephone Company at that time was operating about 6,000 stations in the territory now comprised by the boroughs of Brooklyn, Queens, and Richmond.

On June 1, 1905, eleven years later, there were in service and under contract in Manhattan and the Bronx 164,396 stations. The population of these two boroughs was estimated at this time at 2,400,000, making the ratio of telephones to population 1 to 14, as against 1 to 136 at the beginning of the message rate period. The number of stations in service and under contract in the boroughs of Brooklyn, Queens, and Richmond on June 1, 1905, was over 50,000. Therefore the total number of stations for the five boroughs, the estimated population of which was 4,000,000, was over 214,000, and the ratio of telephones to population throughout Greater New York was 1 to every 18 persons.

On June 1, 1905, 90 per cent of the telephones in the borough of Brooklyn were on the message rate basis. In the borough of Manhattan, where, as has been seen, the number of telephones had increased in the eleven years since the introduction of the message rate from about 11,000 to nearly 160,000, only one-half of 1 per cent were on the old flat rate basis. To be exact, on June 1, 1905, only 858 stations remained under the old type of unlimited service, or flat rate contract.

In the development of the telephone service in New York city many difficult problems have been encountered. The problem of making rates has been one of great complexity. The aim has been to make the service broadly comprehensive, and to accomplish this the conditions prevailing in each of the various parts of the city and the relations between these various parts have been taken into account. It will be seen by the following tables that a large variety of rates are offered, and that while in certain sections flat rates for service in a local area are alone proper, the message rate plan has proved itself the only possible solution of the problem for the great, densely populated boroughs. Present rates in New York city are as follows:

BOROUGH OF MANHATTAN.

Business rates, direct line only.

Number of local messages to be sent in one year.	Annual rate.	Additional local messages.	Number of local messages to be sent in one year.	Annual rate.	Additional local messages.
	Dollars.	*Cents.*		*Dollars.*	*Cents.*
600	60	6	3,000	159	5
800	69	6	3,300	168	5
1,000	78	6	3,600	177	5
1,200	87	6	3,900	186	5
1,500	99	6	4,200	195	5
1,800	111	6	4,500	204	5
2,100	123	6	4,800	213	5
2,400	135	6	5,100	222	5
2,700	147	6	5,400	231	5

Residence rates.

Number of local messages to be sent in one year.	Direct line, annual rate.	Party line, annual rate.	Additional local messages.
	Dollars.	*Dollars.*	*Cents.*
600	54	45	6
800	63	54	6
1,000	72	63	6
1,200	81	72	6
1,500	93	....	6
1,800	105	....	6
2,100	117	....	6
2,400	129	....	6
2,700	141	....	6
3,000	150	....	5

Private branch exchange rates.

	Annual rate.
Minimum equipment, consisting of switchboard with operating telephone, two lines to central office, two telephone stations, and the right to send 3,600 local messages in one year	$216
Additional lines, each	24
Additional stations:	
First 20, each	9
Above 20, each	6
Stations off the premises will be charged for at above rates, plus a charge for mileage based on the actual length of circuit required.	
Additional messages when contracted for in advance in lots of 400, $3 per hundred.	
Excess messages, 4 cents each.	

BOROUGH OF THE BRONX.

Business message rates.

Number of local messages to be sent in one year.	Direct line, annual rate.	Party line, annual rate.	Additional local messages.
	Dollars.	*Dollars.*	*Cents.*
600	48	39	5
800	57	48	5
1,000	66	57	5
1,200	75	66	5
1,500	84	75	5
1,800	93	....	5
2,100	102	....	5
2,400	111	....	5
2,700	120	....	5
3,000	129	....	5
3,300	138	....	5
3,600	147	....	5
3,900	156	....	5
4,200	165	....	5
4,500	174	....	5
4,800	183	....	5
5,100	192	....	5
5,400	201	....	5

Residence message rates.

Number of local messages to be sent in one year.	Direct line, annual rate.	Party line, annual rate.	Additional local messages.
	Dollars.	*Dollars.*	*Cents.*
500	39	30	5
600	42	33	5
800	48	39	5
1,000	54	45	5
1,200	60	51	5
1,400	66	....	5
1,600	72	....	5
1,800	78	....	5
2,000	84	....	5
2,200	90	....	5
2,400	96	....	5
2,600	102	....	5
2,800	108	....	5
3,000	114	....	5

Flat rates—for service in one exchange only.

(*Business.*)

	Direct line.	Party line.
In Kingsbridge, Williamsbridge, Westchester, or City Island.	$48	$36

(*Residence.*)

	Direct line.	Two-party line.	Four-party line.
In Melrose-Tremont	$48	$39	$30
In other districts	36	30	24

(*Toll service.*)

The rate for messages from a station covered by a contract at any of the rates named above to a station connected with another exchange in the Bronx, 5 cents each. (Melrose-Tremont to be considered as one exchange.)

(*Manhattan service for a station located in the Melrose district.*)

Any subscriber who has a listed "Melrose" station may contract for a station to be connected with the nearest Manhattan exchange at the regular Manhattan schedule, plus a mileage charge of $18 per annum. When there is no listed "Melrose" station, the subscriber may contract for Manhattan service under this rule, but in that case the Manhattan station will not be listed.

A station auxiliary to such a station will be furnished at the Manhattan auxiliary line rate, plus $18 per annum.

Private branch exchange rates.

	Annual rate.
Minimum equipment, consisting of switchboard with operating telephone, two lines to central office, two telephone stations, and the right to send 2,400 local messages in one year	$150
Additional lines, each	18
Additional stations, each	6
Additional messages, when contracted for in advance in lots of 400, $3 per hundred.	
Excess messages, 4 cents each.	

BOROUGH OF BROOKLYN.

[Local service within the territory comprising the following central office districts: Main, Bay Ridge, Bedford, Bushwick, East New York, Flatbush, Greenpoint, Hamilton, Prospect, South, and Williamsburg.]

Business message rates.

Number of local messages to be sent in one year.	Direct line, annual rate.	Two-party line, annual rate.	Additional local messages.
	Dollars.	*Dollars.*	*Cents.*
600	54	42	5
800	63	51	5
1,000	72	60	5
1,200	81	69	5
1,400	90	78	5
1,600	99	87	5

Additional messages are sold in lots at $3 per hundred.
Single messages, 5 cents each.

Residence flat rates.

Direct line, annual rate $60
Two-party line, annual rate 48

Residence message rates.

Number of local messages to be sent in one year.	Four-party line, annual rate.	Additional local messages.
	Dollars.	*Cents.*
600	36	5
800	39	5

SMALL AREAS WITHIN NEW YORK CITY LIMITS.

[Local service within each of the following central office districts: Bath Beach, Coney Island, Sheepshead Bay, Barren Island, Astoria, Newtown, Flushing, Richmond Hill, Jamaica, Queens, Hammels, Far Rockaway, New Dorp, and Tottenville.]

Business. Flat rate. Direct.	*Business.* Flat rate. Party.	*Residence.* Flat rate. Direct.	*Residence.* Flat rate. Party.
$43	$36	$36	$24

For local service within the following central office district:

TOMPKINSVILLE—WEST NEW BRIGHTON.

Business.

Direct line $100

Residence.

Direct line $48
Two-party line 39
Four-party line 30

Message rates.

Number of local messages to be sent in one year.	Direct line.	Two-party line.	Additional local messages	Four-party line.
	Dollars.	*Dollars.*	*Cents.*	
600	48	39	5	Guarantee $2.50 per month in local messages, 5 cents each.
800	54	48	5	
1,000	60	54	5	
1,200	66	60	5	
1,500	72	....	5	
1,800	78	....	5	
2,100	84	....	5	

Principal toll rates within New York city from subscribers' stations.

	From Manhattan.	From the Bronx.
	Cents.	*Cents.*
Brooklyn	10	15
Bath Beach	15	20
Astoria	10	15
Newtown	10	15
Flushing	15	15
Coney Island	15	20
Sheepshead Bay	15	20
Barren Island	20	20
Far Rockaway	20	20
Hammels	20	20
Lawrence	20	20
Richmond Hill	15	15
Jamaica	15	15
Queens	15	15
Tompkinsville	15	20
West New Brighton	15	20
New Dorp	15	20
Tottenville	20	20

Pay station rates, 5 cents additional in each case.

A comprehensive readjustment of telephone rates in New York city, made in 1905, affected practically all of the schedules throughout the city. This readjustment, so far as the rates in Manhattan and the Bronx were involved, was made in connection with an "Inquiry into the Telephone Service and Rates in New York City" by the Merchants' Association of that city, acting through a special committee consisting of officers of the association and other representative business men. After a thorough and exhaustive inquiry the Merchants' Association published the results of its work in a report dated June, 1905. The following quotations from that report showed the views of the association with respect to the general principles embodied in the various rate schedules in force in New York city:

A system which exacts an average uniform charge for widely varying degrees of service is obviously inequitable to the public. The flat rate is also harmful to the public in another way. Such a rate, comprehending all classes of business users and based upon the average of wide extremes, of necessity compels small users to pay a relatively higher rate than they would pay under a graded rate based upon the cost of the service used by them, and is therefore highly burdensome to such users, and presents *a formidable obstacle to the development of the telephone system.* This condition is of course detrimental to a telephone company as well as to its patrons. Moreover, the effect of a flat rate is to increase the individual use of the telephone equipment and the individual demand upon the operating force, thereby increasing operating expenses without providing additional income. Under a flat rate system with a definitely restricted income it is imperative that the tendency of operating expenses to increase disproportionately by reason of unlimited calls be counteracted. The necessary economy can only be effected at the expense of efficiency.

It is the opinion of this committee, therefore, that in large cities the flat rate with unlimited service is based upon a fallacy, that it is extremely unjust to small users, favors large users unduly, impedes expansion of the telephone business, tends to inefficient service, and that as a financial proposition it is unsound.

The flat rate system, however, is quite suitable for small places. In a small system the conditions are fairly equal for all subscribers. The amount of plant used and the amount of operating labor required by the various subscribers show no extreme variations, and a flat rate meets the circumstances quite fairly, while it avoids the extra work of registering the messages. * * *

A telephone station and collateral equipment represent a definite capital outlay, and a continuous outlay for the maintenance of an operating staff in readiness, irrespective of the number of calls made. The message rate must provide for this fixed charge. If the calls are few, the message rate should be relatively high. If the calls are many, the rate should be relatively low. It is obvious, also, that a great volume of calls further greatly reduces the pro rata operating expense, and therefore warrants a gradually decreasing rate of charge.

Hence the general principle of a graded scale, beginning with a relatively high maximum rate for small users, declining to a relatively low minimum rate for large users.

The New York Telephone Company's scale of charges is based upon this equitable principle. Each subscriber pays only for the service actually used by him, at a rate bearing a definite and just relation to the cost of serving him. The equity of this system is obvious.

* * * In a large area embracing widely differing localities, in various stages of development, whether or not they are in the same municipality, the public interest, in the opinion of this committee, is best served by the application of various rates to the various localities, in such manner as to meet the peculiar requirements of each section or locality, with an appropriate rate or plan of rates. This method of treatment has been followed in Greater New York. Within New York there are many local districts where most of the traffic is local and, therefore, does not involve general intercommunication with distant parts of the city. Excluding such distant connections and considering only local interchange, local service is on a basis of local cost and a moderate charge is possible. Some of these localities are of such character, and the variation in use among the various subscribers is so small that flat rates for unlimited local service are proper and most advantageous to the locality.

* * * * *

In practice local rates are in use in each of the districts of New York city, the rates varying with the conditions in the various districts; in the outlying districts they are very materially less than are charged for the wider service supplied in the central districts of Manhattan and Brooklyn. In addition to the rates for local service an extra or toll rate is charged for connection with other districts, thereby imposing an extra rate only upon those who make use of the extra service.

The principle upon which this system of charging is based seems sound and reasonable. In its application, however, there are inevitable inequalities and some hardships to be borne by individual users, but these are inherent in any zone system. Without most careful consideration of the whole question of telephone rates as worked out and applied in each section of the city, these extra charges for distant connections may be considered irksome and unnecessary, but after mature consideration, it is the opinion of this committee that while these charges should always be moderate, the principle of imposing them should be maintained, as it is believed to be sound and reasonable and in the best interests of the telephone using public as a whole.

The figures given on page 60 show the growth in the boroughs of Manhattan and the Bronx and in Greater New York. These figures and the two illustrations following show the division of the city into central office districts and the number of telephones in each district at the introduction of the message rate and at the present time.

Number of telephones in service.

JANUARY 1—	In the boroughs of Manhattan and the Bronx.	In New York city (Greater New York).
1881	2,973	....
1889	7,454	....
1894	11,218	....
1898	23,046	31,474
1899	28,423	38,315
1900	40,437	52,590
1901	54,650	70,263
1902	72,182	91,096
1903	96,359	120,491
1904	121,935	151,848
1905	144,353	180,801

Central offices and number of telephones in Greater New York, January 1, 1894.

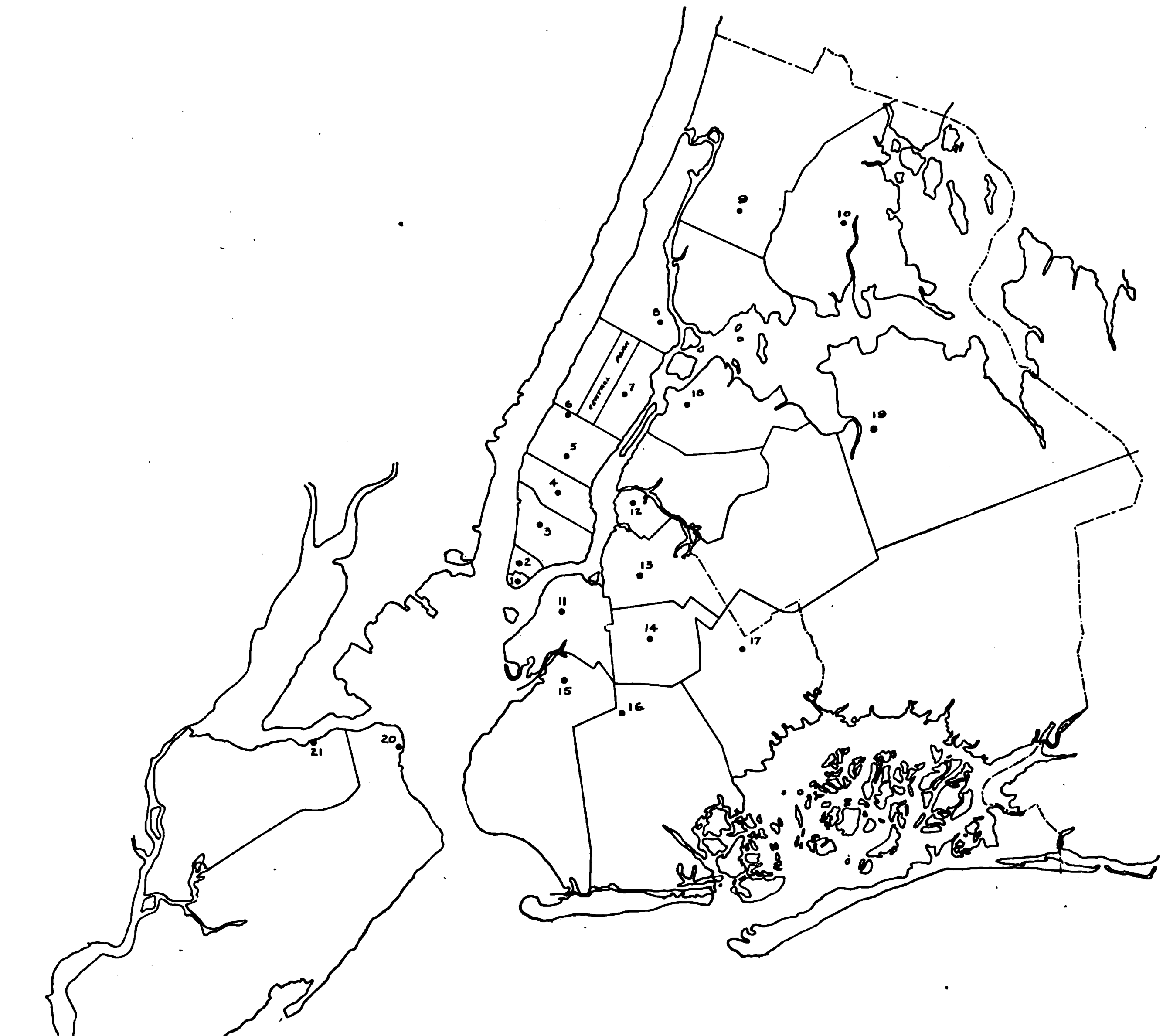
District No.[1]	CENTRAL OFFICE.	Number of telephones.	District No.[1]	CENTRAL OFFICE.	Number of telephones.
	BOROUGHS OF MANHATTAN AND THE BRONX.			BOROUGH OF BROOKLYN—continued.	
1....	Broad	1,035	15...	South	306
2....	Cortlandt	3,623	16...	Flatbush	68
3....	Spring	1,386	17...	East New York	169
4....	Eighteenth street	1,073		Total	4,509
5....	Thirty-eighth street	1,288		BOROUGH OF QUEENS.	
6....	Columbus	320	18...	Astoria	47
7....	Seventy-ninth street	384	19...	Flushing	79
8....	Harlem	488		Total	126
9....	Tremont	10		BOROUGH OF RICHMOND.	
10....	Westchester	20	20...	Tompkinsville	143
	Total	9,627	21...	West New Brighton	123
	BOROUGH OF BROOKLYN.			Total	266
11....	Brooklyn	1,847			
12....	Greenpoint	299			
13....	Williamsburg	1,185			
14....	Bedford	635			

[1] See illustration on page 61.

Central offices and number of telephones in Greater New York, January 1, 1905.

District No.[1]	CENTRAL OFFICE.	Number of telephones.	District No.[1]	CENTRAL OFFICE.	Number of telephones.
	BOROUGH OF MANHATTAN.			BOROUGH OF BROOKLYN—continued.	
1....	Broad	11,418	32...	Bay Ridge	1,140
2....	Cortlandt	14,707	33...	Flatbush	1,684
3....	John	9,297	34...	East New York	1,273
4....	Franklin	7,974	35...	Bath Beach	339
5....	Orchard	3,383	36...	Sheepshead Bay	125
6....	Spring	7,874	37...	Coney Island	285
7....	Chelsea	3,630	38...	Barren Island	6
8....	Gramercy	10,516		Total	31,775
9....	Madison Square	9,748		BOROUGH OF QUEENS.	
10....	Thirty-eighth street	15,203	39...	Astoria	287
11....	Columbus	8,556	40...	Newtown	271
12....	Plaza	7,172	41...	Flushing	674
13....	Seventy-ninth street	4,806	42...	Richmond Hill	356
14....	Riverside	9,352	43...	Jamaica	424
15....	Morningside	8,251	44...	Queens	29
16....	Harlem	4,127	45...	Hammels	201
17....	Highbridge	343	46...	Far Rockaway	230
	Total	136,357		Total	2,572
	BOROUGH OF THE BRONX.			BOROUGH OF RICHMOND.	
18....	Melrose	2,407	47...	Tompkinsville	1,081
19....	Tremont	1,086	48...	West New Brighton	693
20....	Westchester	281	49...	New Dorp	90
21....	City Island	49	50...	Tottenville	128
22....	Kingsbridge	194			1,992
23....	Williamsbridge	187		Total exchange stations, 5 boroughs	176,900
	Total	4,204		Private line telephones, 5 boroughs	3,901
	BOROUGH OF BROOKLYN.			Total	180,801
24....	Main	7,030			
25....	Greenpoint	1,990			
26....	Williamsburg	3,939			
27....	Hamilton	1,137			
28....	Prospect	4,700			
29....	Bedford	4,053			
30....	Bushwick	2,135			
31....	South	1,939			

[1] See illustration on page 62.



TELEPHONE CENTRAL OFFICES AND CENTRAL OFFICE DISTRICTS IN NEW YORK CITY JANUARY 1, 1894; 21 CENTRAL OFFICES AND 14,528 TELEPHONES

TELEPHONE CENTRAL OFFICES AND CENTRAL OFFICE DISTRICTS IN NEW YORK CITY JANUARY 1, 1905; 50 CENTRAL OFFICES AND 180,801 TELEPHONES.

CHAPTER XI.

HISTORY AND DEVELOPMENT OF TELEPHONY.

Early development.—The history of the telephone, like that of the telegraph, as indeed of any other great invention, is full of conflicting claims as to priority of discovery. But it is a fact beyond dispute that in 1876, at the moment of Bell's invention of his speaking telephone, there was not a single operative telephone in the hands of the public anywhere in the world. The whole art and industry of which this report makes record dates from 1876–77. As early as 1837 Page discovered that an iron bar when magnetized and demagnetized at short intervals of time emits sounds, due to the molecular disturbances of the mass. Reis, in Germany, utilized this fundamental principle and constructed apparatus for the transmission of sound to a distance by electrical means. Prior to that the idea of telephony had been defined by a young French soldier in Algeria, Joseph Bourseul, who in 1848 had attracted the attention of the authorities by mathematical instruction which he gave to his fellow soldiers in the garrison. The journal "L'Illustration de Paris," August 26, 1854, under the title of "Electrical Telephony," described his apparatus, or the idea embodied, as follows:

> No further machinery and knowledge except a galvanic pile (battery), two vibrating plates, and a metallic wire needle. Without other preparation one would only have to talk against one of the metallic plates, and another would have to hold his ear against the other plate. In this way they could converse with each other.

This is a brief, lucid description of the telephonic principle, but so far as can be ascertained it was never elaborated in practical work, and if any one ever saw Bourseul's telephones there is certainly none in existence to-day. Reis, however, went further and actually built apparatus which could be made to transmit not merely sound, it is claimed, but human speech. In his biographical notes, written in 1868, Professor Reis says:

> Incited thereto by my lessons in physics, in the year 1860 I attacked a work, begun much earlier, concerning the organs of hearing, and soon had the joy of seeing my pains rewarded with success, since I succeeded in inventing an apparatus by which it is possible to make clear and evident the functions of organs of hearing, and with which, also, one can reproduce tones of all kinds at any desired distance by means of the galvanic current. I named the instrument *telephon*. The recognition of me on so many sides which has taken place in consequence of this invention, especially at the Naturalists' Association at Gnesen, has continually helped to quicken my ardor for study that I may show myself worthy of the luck that has befallen me.

A number of exhibitions of his apparatus were given by Reis in the period 1861–1864, and duplicates of the apparatus were sent to various parts of the world, Professor Clifton making a demonstration with it before the Manchester Literary and Physical Societies of England in 1865. A discussion by Reis in the Yearbook of the Physical Society of Frankfort for 1860–61 points to the fact that every tone or combination of tones entering the human ear causes its membrane or eardrum to vibrate. The motion of these vibrations produces the sense of sound, and every change in the motion must necessarily be accompanied by a change in the sensation. Hence it would be possible to transmit such sounds electrically, set up vibrations or curves like those of any given tone or combination of tones, and receive the same impression as the tone itself would have produced.

This idea he elaborated into an apparatus built upon the principle of the human ear, to which the earliest forms had a rough but striking resemblance. The first apparatus thus made, for example, embodied a small cone, covered at its lesser end with an animal membrane, upon which a small platinum strip or wire was fastened by means of sealing wax. The receiver consisted of a violin, upon which a knitting needle having a coil wound around it was fastened. When the sound waves made the membrane vibrate, the circuit was closed as they impinged and the strip of platinum beat against a tip of metal, the degree of contact being altered with each vibration. The sound waves threw the electric current at the point of variable contact into pulsations of varying strength, and corresponding effects were produced at the receiving end.

There were twelve novel and ingenious forms of the Reis apparatus worked out, all embodying in some way the idea of the human ear, with its auditory tube, tympanum, etc. The first form of apparatus used by Reis as a receiver consisted of a steel knitting needle, around which was wound a spiral coil of silk-covered copper wire. As it was soon found that the sounds produced by rapid magnetization and demagnetization could be improved by the addition of a sounding box the needle was mounted upon the sounding board of a violin. A cigar box was tried, also, and the final form of the knitting needle receiver adopted by Reis was essentially of this box type; the needle and its helix lay on a rectangular sounding box of thin pine wood, and the coil of wire was mounted upon a light wooden bobbin instead of being twisted around the needle itself. Two wooden bridges or supports held the ends of the needle, and over the needle was thrown a hinged box lid. As originally constructed, this lid when closed pressed tightly upon the steel needle; and Reis's own instructions were to press the lid firmly against the needle in order that the sound might be intensified, as was done unconsciously by the listeners with their ears against the lid in order to hear more distinctly. At the end of the sounding box was a little telegraph key, used to interrupt the circuit and to telegraph signals back to the transmitting end.

There is a variety of testimony alleging that not only musical sounds but words and phrases were actually transmitted, as they can be to-day in modern models of this apparatus; but since the invention rested upon the make-and-break principle, the circuit having to be made and broken every time a sound impulse was transmitted, it was so extremely delicate that it was impossible to maintain it in adjustment for more than the shortest space of time. As Reis himself said to Herr Garnier, to whom he disposed of his instrument and tools, he had shown the world the way to a great invention which must be left to others to develop. A warm appreciation of the work of Reis has been shown in this country and Europe, and in 1878 a monument was erected to his memory at Frankfort, an inscription on which styled him "the inventor of the telephone."

One of the American judges, in deciding an early litigation over the invention of the telephone, said epigrammatically that however ingenious this pioneer work may have been, a hundred years of Reis would never have given the world the telephonic art for public use as it exists to-day. Many attempts were made to apply in practical apparatus the make-and-break principle of Reis, both before and after the invention of the Bell telephone, and some of the workers in this field devised transmitters approaching the modern microphone now so essential. But, as has already been stated, the telephone up to 1876 was utterly unknown to the public, and the scientific apparatus for laboratories and schools, formerly bearing the name, remains even to this day virtually incapable of improvement that would bring it within the sphere of public utility.

The work of Bell.—The art of speaking telephony had to find its future and perfection in some other direction than the make-and-break method and pulsatory currents of Reis, suggestive and helpful as such work must necessarily have been to all who were familiar with it. In 1876 the attention of the world was arrested by the issue on March 7 of Alexander Graham Bell's original patent. The application for this patent which, when granted, bore the number 174465, was filed on February 14 of the same year at the conclusion of considerable experiment and investigation. In 1875 Bell, who as a student and teacher of vocal physiology had unusual qualifications for determining feasible methods of speech transmission, constructed his first pair of magneto telephones. Each of these consisted of an electro-magnet, a U-shaped iron bar around one limb of which a coil of wire was wound, while a thin iron plate, or armature, was hinged to the other, extending also over the wire-surrounded core. A membrane diaphragm stretched across the tube served as a mouthpiece, being mounted in a frame having its center immediately opposite the active pole of the magnet to which the iron armature was attached. Throughout 1875 Bell experimented with apparatus of this character, varying the proportions and arrangements of the coil, the magnets, the armature, etc., and virtually such apparatus was figured and described in the patent specifications, with the addition of hollow cones or small speaking trumpets attached to the armature membranes in order to concentrate the voice at the transmitting end and assist the ear at the receiving end.

The first published account of the speaking telephone was a paper read by Bell before the American Academy of Arts and Sciences in Boston on May 10, 1876, and in the summer of that year the crude mechanism was exhibited at the Centennial Exhibition at Philadelphia and elicited the enthusiastic admiration of the world's leading physicists. During the same year Bell experimented with the substitution of a permanent magnet for the electro-magnet, and toward the end of the year he generally employed the permanent magnet, omitting the battery. Over short distances virtually identical results are obtainable with the permanent magnet and with the electro-magnet; but it was early found that the magneto telephone had very definite limitations as to distance of operation and clearness of utterance. For both kinds of apparatus the great step that Bell made was to devise a mechanism that produces undulations of the electric current in the circuit, corresponding to the sonorous vibrations of the voice, thus rendering practicable the continuous and intelligible transmission of human speech. The principle thus discovered and embodied in practical apparatus was defined as follows in the specifications of the Bell patent:

Electrical undulations induced by the vibration of a battery can be represented graphically without error by the same sinusoidal curve which expresses the vibrations of the inducing battery itself and the effect of its vibration upon the air: for, as above stated, the rate of acceleration in the electrical current corresponds to the rate of vibration of the inducing body, that is, to the pressure of sounds produced. The intensity of the current varies with the amplitude of the vibrations, that is, with the loudness of the sound; and the polarity of the current corresponds to the direction of the vibrating battery, that is, to the condensation and rarefaction of the air produced by the vibration.

This principle is summed up in claim 5 of the patent, as follows:

The method of an apparatus for transmitting vocal air into sounds telegraphically, as herein described, by causing electrical undulations similar in form to the vibrations of the air accompanying the said vocal air into sound substitutes as set forth.

The apparatus shown at the Centennial Exhibition was improved very rapidly and the receiving part of the magneto telephone soon assumed the shape which has long been familiar. The iron plate armature and the connected diaphragm soon became one member, and a single sheet iron diaphragm, or disk, such as is used in modern practice, was adopted. The coil of wire around the magnet was shortened until it became the flat bobbin, or spool, that is now a characteristic feature of the receivers, placed at the end of the magnet nearest the diaphragm, and the speaking trumpet, or cone, of the resonating space was flattened until it became the shallow cup which enables one to rest the ear directly upon the telephone. In August, 1876, Mr. Bell experimented on a five-mile telegraph circuit in Canada, and on the evening of October 9 the first long conversation ever carried on telephonically was exchanged upon a telegraph line extending from the office of the Walworth Manufacturing Company in Boston to their factory in Cambridge, Mass. Every word of this conversation was recorded at both ends. In November of the same year a telephone was used over 200 miles of circuit between Boston and Salem, Mass., by way of North Conway, N. H., and a little later a conversation was carried on by Mr. Bell between Boston and New York over a Western Union telegraph circuit. The apparatus in all these demonstrations was the magneto telephone as distinguished from the battery type. About this time capital began to be interested, and a circular was issued to invite the support of the public for the new means of communication, which ran as follows:

The proprietors of the telephone, the invention of Alexander Graham Bell, for which patents have been issued by the United States and Great Britain, are now prepared to furnish telephones for the transmission of articulate speech through instruments not more than twenty miles apart. Conversation can easily be carried on after slight practice and with the occasional repetition of a word or sentence. On first listening to the telephone, although the sound is perfectly audible, the articulation seems to be indistinct; but after a few trials the ear becomes accustomed to the peculiar sound and finds little difficulty in understanding the words.

The telephone should be set in a quiet place, where there is no noise which would interrupt ordinary conversation.

The advantages of the telephone over the telegraph for local business are:

1st. That no skilled operator is required, but direct communication may be had by speech without the intervention of a third person.

2d. That the communication is much more rapid, the average number of words transmitted in a minute by the Morse sounder being from fifteen to twenty, by telephone from one to two hundred.

3d. That no expense is required, either for its operation, maintenance, or repair. It needs no battery and has no complicated machinery. It is unsurpassed for economy and simplicity.

The terms for leasing two telephones for social purposes, connecting a dwelling house with any other building, will be $20 a year; for business purposes $40 a year, payable semiannually in advance, with the cost of expressage from Boston, New York, Cincinnati, Chicago, St. Louis, or San Francisco. The instruments will be kept in good working order by the lessors, free of expense, except for injuries resulting from great carelessness.

Several telephones can be placed on the same line at an additional rental of $10 for each instrument, but the use of more than two on the same line where privacy is required is not advised. Any person within ordinary hearing distance can hear the voice calling through the telephone. If a louder call is required, one can be furnished for $5.

Telegraph lines will be constructed by the proprietors if desired. The price will vary from $100 to $150 a mile; any good mechanic can construct a line. No. 9 wire costs 8½ cents a pound, 320 pounds to the mile; 34 insulators at 25 cents each; the price of poles and setting varies in every locality; stringing wire, $5 per mile; sundries, $10 per mile.

Parties leasing the telephones incur no expense beyond the annual rental and the repair of the line wire. On the following pages are extracts from the press and other sources relating to the telephone.

Cambridge, Mass., May, 1877.

So far the telephone had not been developed beyond the connection of two stations by a single line, but it had been a conception of Bell from an early date that there should be a central office having the function of making connection whenever desired between the lines of the several subscribers. In lectures given in the spring of 1877 in Connecticut and New York by Mr. Bell and his associates this idea was plainly set forth, outlining in a broad way both the exchange system and the long distance telephone.

First commercial telephony.—On April 4, 1877, the first line ever built specially for telephone uses was put in operation between the factory of Charles Williams, jr., of Boston, and his home at Somerville, Mass., and shortly afterwards a number of other lines of this character were erected. To many persons the telephone seemed only a toy, and difficulty was found in interesting investors. When people began to recognize the utility of the invention, Mr. Bell and his associates saw the need of an organization for dealing with the commercial features of the enterprise; hence in 1877 an informal, unincorporated association, known as the Bell Telephone Association, was formed. This association had no capital and few members, and its objects were to assist Gardiner G. Hubbard, to whom, as trustee, the Bell patents had been assigned, and to devise the best means for the general commercial introduction of telephones. The exchange idea was first carried into effect in a crude way in Boston, in May, 1877, in connection with the protective circuits of the Holmes Burglar Alarm Company. The various lines communicating with financial establishments were brought to a small switchboard at the Holmes central station, and the circuits were repeatedly interconnected at this board. As a matter of historical fact, however, the first telephone central office system was that established at New Haven, Conn., and opened for business on January 25, 1878, this being the first fully equipped commercial telephone exchange ever established for public or general service. The advantages of the telephone exchange were instantly seen, so that by March, 1881, or three years later, there were in the United States only nine cities of more than 10,000 inhabitants and only one of more than 15,000, in which a telephone exchange had not been established.

This rapid growth soon made evident the need of a more formal organization of the business, and in February, 1878, the New England Telephone Company was organized, with a capital of $200,000. This company was given exclusive rights and license to use and to manufacture telephones in New England. In July, 1878, the Bell Telephone Company was formed, with a capital of $450,000, with exclusive rights for the remainder of the United States. In March, 1879, these two companies were consolidated into the National Bell Telephone Company, with a capital of $850,000. By this time the commercial success of the business had become assured, and in March, 1880, as the National Bell Telephone Company was not broad enough in its business scope to meet the demands of the situation, the American Bell Telephone Company, with a capital of $10,000,000, was formed. This company displayed great ability in developing, through subsidiary companies, the telephone business of the country on a territorial license basis and continued to operate until 1899, when it was absorbed by the American Telephone and Telegraph Company, which had been created originally for the purpose of handling the long distance business of the American Bell Telephone Company.

The original circular of the Bell Telephone Association stated that the effective limit of speech was 20 miles, but this limit did not long remain fixed. By the beginning of 1881 the work of connecting cities and towns by telephone circuits was well under way. Boston was connected with 75 cities and towns, the lines reaching as far as Springfield. In 1884 the success of the experimental long distance line between Boston and New York convinced everyone that conversation over distances of from 200 to 300 miles was practicable, but owing to the difficulties experienced in securing terminal facilities, it was 1887 before the longer lines were opened to commercial use. Extensions of these lines were pushed steadily and on October 18, 1902, the line between New York and Chicago was opened, while in the following February the Boston-Chicago line was put in service. The maps of the lines as they existed in 1895 and as they were in 1904 show plainly the immense growth of the long distance system and indicate, to a large degree, the cause for the rapid rise in the use of the telephone. The whole country is now being connected so that all may talk from one end of it to the other.

Early telephone competition.—Part of the early development was not due to the Bell Telephone Company, but to its active competitor, the Western Union Telegraph Company, which in 1877, seeing in the telephone a dangerous rival to the telegraph, began to develop a telephonic system and network of its own, based upon the work of Elisha Gray, T. A. Edison, and others. By one of the most extraordinary coincidences in the history of invention, Elisha Gray had filed in the Patent Office at Washington a caveat for "a new art of transmitting vocal sounds telegraphically" on February 14, 1876, the same day on which Bell had filed his application. The Gray apparatus differed, however, from that of Bell. In the Gray caveat was described a liquid transmitter so utilized that the vibrations of the plunger, a rod attached to the membrane, would cause variations in resistance, and consequently modify the current passing through the circuit to the receiver. A pencil drawing illustrating this ingenious idea was made by Gray in February, 1876, but the liquid transmitters brought out from time to time by Gray and others have never played any part in the art. Edison, however, who was then in the service of the Western Union Company, succeeded in producing an excellent carbon transmitter, a device in which the variations of resistance due to change of pressure in a mass of carbon effected the necessary variations in the electrical current carrying the impulse vibrations, and this microphonic principle is a feature of all the successful speech-transmitting apparatus of the present day. In the meantime Emil Berliner and Francis Blake had developed excellent battery or carbon transmitters for the Bell system. Through the agency of the American Speaking Telephone Company the Western Union Telegraph Company pushed its telephone system vigorously throughout the country, until it had a large number of exchanges in operation. Patent litigation between the rivals began in September, 1878, whereupon, conceding the priority of the Bell invention, the Western Union Company effected a famous agreement under which, by agreeing to pay 20 per cent of its income to the Western Union Company during the life of the contract, seventeen years, the Bell Company obtained complete possession of the field, acquiring all the telephonic inventions, apparatus, and exchanges of the Western Union system. The result of this combination was not alone to unify the commercial telephonic systems of the whole country, but to harmonize and standardize the apparatus, and thus to permit industrial and scientific development.

The Bell telephone system was at the start immediately introduced in Europe, but there, as here, the Bell patents throughout the entire term of their existence, although frequently sustained wholly or in part, were subject to tremendous patent and legal attack and competition in all forms, and the telephonic art has enjoyed the benefit of the labor of many prominent inventors invited by the opportunities and rewards offered in this field. It was necessary to develop not only the apparatus used at each end of the circuit but the apparatus at the exchange, which at first was very crude. The central offices were equipped with switchboards similar in construction and operation to those employed in telegraph offices, but these were very rapidly outgrown. Other chapters of this report treat more specifically of the apparatus at the central station, as well as of that employed at the subscriber's substation.

The changes wrought since the American Bell Telephone Company assumed charge of the business are summed up admirably in the following paragraph from the Boston Electrical Handbook of 1904, issued under the auspices of the American Institute of Electrical Engineers:

> In the twenty-four years which have elapsed since that time, reliable low capacity poly-conductor cables, mainly employing air as an insulating medium, have been devised and their employment has become universal; underground construction has become the rule instead of the exception; beginning with the year 1883, a metallic circuit system of long distance lines has been built of hard drawn copper wire and has overspread the country; the average excellency of these long lines, terminating as they do in switchboards at exchange central stations, has resulted in correspondingly improved construction in exchanges everywhere, including the substitution of copper for iron as a material for line wire, and the metallic circuit for the ground return single conductor line; the operating companies now have their own buildings specially designed to accommodate the central station operating rooms, and affording facilities for the ingress of the subterranean cables; an elaborate system of protection has been provided for both ends of each telephone line, and where such lines pass through cables, at the cable ends also, to take care of trespassing currents strong enough to be destructive; and lastly, but by no means of least importance, the old and well-known hand operated magneto machine for years the most approved call-sending apparatus, and the multitudinous batteries of which one was provided with the transmitter of each user to furnish current for its operation, have both been superseded in the modern well-appointed exchange, by a single central station battery which supplies not only the electric current for all the transmitters of the outlying stations, but also for the transmitters of a central station, and for the switchboard call and supervisory signals. By this change a few cells of battery are enabled to take the place and do the work of many, and the establishment of the few retained cells at the central station where they may always be under skilled supervision is provided for.

Independent development.—During the first half of the term of the Bell patents a number of rival systems were brought into existence by competitors, that of the Western Union Company, already noted, being the most formidable and extensive. After the consolidation none appeared able to sustain the burden of the struggle, and a period of some years succeeded during which the telephone industry remained a virtual monopoly in the United States. As the term of the fundamental patents drew to a close, however, competition raised its head again and independent exchanges were started in various parts of the country. At first these made their appearance only in places that under the exclusive Bell régime had not enjoyed the benefit of telephonic service, but the independent movement soon assumed formidable proportions and its promotors invaded the larger cities, so that at the time of the present report independent exchanges are found in successful operation in such places as Chicago, Cleveland, St. Louis, Philadelphia, and Indianapolis. The independent movement, however, was particularly fostered and pushed in rural districts, and there it still enjoys its best patronage, as is evidenced by the statistics presented elsewhere in this report. The independent movement has not only created a vast network of exchanges and interconnecting lines, but has called into being a large number of manufacturers and a great variety of apparatus, so that, while a few years ago the telephonic art in the United States had attained a high degree of standardization, it is once more marked in some degree by the confusion and heterogeneity that characterized its earlier years. Such conditions are always associated with rapid growth, and in the field of telephony they constitute at the present time a remarkably interesting problem with many sociological, industrial, and mechanical aspects.

CHAPTER XII.

TELEPHONY IN FOREIGN COUNTRIES.

General data.—The introduction of the telephone in the United States was followed almost immediately by its adoption in all the countries of Europe and more slowly in other parts of the world. But while in the United States its development has remained exclusively in private hands and has been developed by corporations, in Europe the telephone and telegraph lines have remained almost exclusively subject to Government control. In only two foreign countries—Great Britain and Sweden—has there been any notable exception to this rule, and while this report has been in preparation the British Government has completed with the National Telephone Company, which has controlled the Bell telephone system for many years past, a long series of negotiations by which in a few years the Postal Telegraph service will take over the entire network of telephone lines in Great Britain.

The tremendous rate of development of the telephone in the United States compares very strikingly with the slow rate of development in Europe, and the facts connected with this contrast would constitute, if taken by themselves, a notable argument in favor of private enterprise, but there are necessarily many other conditions involved in the situation.

The textual statements with regard to European development embody statistics dating generally up to the end of 1902, thus bringing them in fair comparison with those upon which the present report is based. But a tabular survey of the situation at the close of 1904 is also given. This presents a comparative study of the telephone industry in the United States and in Europe, furnishing the latest authentic figures available.

These figures are massed into two tables which are presented herewith. Table 41 gives the telephone statistics as of January 1, 1905, for the United States, Sweden, Denmark, Switzerland, Norway, the German Empire, the United Kingdom, Holland, Belgium, France, Austria-Hungary, Spain, Italy, and Russia. Table 42 presents figures relating to telephonic development in the following larger cities of the Old World and the New: Stockholm, New York, Christiania, Copenhagen, Zurich, Berlin, London, Paris, Brussels, Vienna, Amsterdam, Rome, Budapest, Lisbon, St. Petersburg, and Madrid. The population is stated in round numbers in these two tables.

TABLE 41.—*Telephone development, United States and Europe.*

[January 1, 1905.]

COUNTRY.	Population.	Telephones.	Inhabitants per telephone.	Telephones per 1,000 inhabitants.
United States	76,000,000	3,400,000	22.2	44.8
All Europe		1,485,784		
Sweden	5,250,000	112,250	46.8	21.4
Denmark	2,500,000	41,650	60.0	16.7
Switzerland	3,300,000	52,509	62.7	15.9
Norway	3,000,000	41,500	72.2	13.8
German Empire	58,000,000	518,489	112.0	8.9
United Kingdom	42,000,000	365,198	115.0	8.7
Holland	5,300,000	29,500	180.0	5.6
Belgium	7,000,000	24,750	284.0	3.5
France	39,000,000	122,191	320.0	3.2
Austria-Hungary	48,000,000	74,600	644.0	1.6
Spain	18,600,000	16,000	1,160.0	0.9
Italy	32,000,000	27,147	1,180.0	0.8
Russia	135,000,000	60,000	2,250.0	0.4

TABLE 42.—*Telephone development in large cities.*

[January 1, 1905.]

CITY.	Population.	Telephones.	Inhabitants per telephone.	Telephones per 100 inhabitants.
Stockholm (two systems)	312,000	42,685	7.3	13.7
Stockholm (company system only)	312,000	31,685	9.8	10.2
New York	2,100,000	144,353	14.5	6.9
Christiania	230,000	12,513	18.3	5.4
Copenhagen	476,000	23,000	20.6	4.8
Zurich	153,000	7,275	21.0	4.8
Berlin	1,931,000	66,744	29.0	3.4
London	4,614,000	93,598	49.5	2.0
Paris	2,660,000	49,444	54.0	1.8
Brussels	576,000	7,829	73.7	1.4
Vienna	1,762,000	21,723	83.0	1.2
Amsterdam	543,000	6,081	89.5	1.1
Rome	500,000	5,000	100.0	1.0
Budapest	800,000	7,500	106.5	0.9
Lisbon	370,000	1,740	212.0	0.5
St. Petersburg	1,334,000	6,000	223.0	0.4
Madrid	550,000	2,400	229.0	0.4

With regard to the general table for the countries, it will be observed that the United States had, at the end of 1904, 3,400,000 telephones, or more than twice as many as all Europe, the total for England and the Continent being 1,485,784. The figures for one or two minor countries not included might possibly raise the European total to 1,500,000. The fact is also brought out that owing to the rapid development of the Bell telephone system, as well as the active competition of independent companies, the proportion of telephones to population in the United States has been raised from 1 telephone to 34 inhabitants in 1902 to 1 telephone to 22.2 inhabitants in 1905. It will also be seen that at the later date there were in the United States 44.8 telephones per 1,000 inhabitants, which was more than twice as great as the highest rate in Europe, namely, that of Sweden, with 21.4. Some of the European countries exhibited a very small utilization of the telephone. The second most active commercial and industrial countries, namely, the German Empire and the United Kingdom, showed only 8.9 and 8.7 telephones, respectively, per 1,000 inhabitants, this figure falling off to 3.2 in France and to 1.6 in Austria-Hungary. In the great empire of Russia there were, at the date named, only 60,000 telephones, or less than in the borough of Brooklyn, New York city.

The table of telephone development in large cities is also very instructive and interesting. In this table New York heads the list, with the exception of the city of Stockholm, where unusual activity has been displayed for some years past through the competition of the Government and a private system, with the result that each has virtually duplicated the other's service at low and unprofitable rates, giving what may fairly be characterized as an undue or abnormal development without intrinsic benefit to the community. The Swedish figures are discussed in greater detail below. Admitting, however, that the percentage in New York, as in all other great cities, is destined to rise until a much higher point than the present has been attained, it is to be noticed that in the city of Christiania, which from many points of view might be compared with Stockholm, the proportion of telephones per 100 inhabitants is slightly less than in New York, being 5.4, as compared with 6.9 in the American city. The great cities of Europe which should justly be compared with New York, namely, London, Paris, Berlin, and Vienna, show a comparatively small patronage of the telephone, the figures being, London, 2 telephones per 100 inhabitants; Paris, 1.8; Berlin, 3.4; and Vienna, 1.2. It should be mentioned in passing that London has two telephone systems, a private and a Government one. The figures include both systems. The population of London, in comparative statistics, is more usually given as 6,580,000, the use of which would bring the figures for the use of the telephone much nearer the low average for Paris and Vienna, and still further below that for Berlin. But the figures here employed (4,614,000) are those which are considered to govern more specifically the telephone area. With regard to these figures and those which might be presented for American cities other than New York, the remark of John Hesketh, telephone engineer for the Australian Government, may be quoted as follows: "In American cities the telephone development has already reached a point which seems hardly to be realized as within the bounds of possibility in most European countries."

Subjoined will be found a few specific statistics with regard to the telephonic traffic in the leading countries of Europe for the year 1902-3, the period being the one most closely corresponding to that covered by the statistics for the United States. The statistics in question are those compiled by and published in the Journal Telegraphique, issued in Berne, Switzerland, by the official international bureau of telegraphic administration. This bureau receives the reports of the various governments of Europe, and being in direct touch and constant communication with them is enabled to present authentic data that otherwise is not easy to obtain.

Germany.—For the period under consideration the statistics for Germany, not including the German protectorates in China and Africa, show 4,192 "reseaux" or exchange systems, 71,052 kilometers (44,150 miles) of pole line in the cities, and 2,399 kilometers (1,491 miles) of underground line. This gave a total length of wire circuit overhead and underground of 1,383,814 kilometers (859,923 miles). There were also 8,675 interurban circuits, with 248,376 kilometers (154,396 miles) of wire circuit. It is noted in the return that most of this circuit hitherto had been that of earth return, but that the metallic circuit, such as now prevails so uniformly in America, was in process of introduction. The system included in 1902-3, 470,365 stations, of which 444,720 were those of subscribers, 21,438 were public pay stations, and 4,207 were central stations. The total number of conversations or uses of the service within urban limits was 799,009,646, of which 793,582,447 were ordinary subscribers' talks. Of the remainder, 2,423,256 were ordinary pay station talks. In addition to the above the other urban or toll line conversations numbered 128,268,985. The total receipts of the system were 72,867,441 francs ($14,063,416), of which 53,026,074 francs ($10,234,032) came from subscribers in city limits.

Austria.—The figures for Austria and Hungary are reported separately by the bureau. There were in Austria 429 exchanges with 10,086 kilometers (6,267 miles) of line, of which 264 kilometers (164 miles) were underground, and a total wire circuit of 255,725 kilometers (152,686 miles). The interurban circuits numbered 134, with 21,404 kilometers (13,300 miles) of wire. The substations numbered 43,742, of which 42,641 were those of subscribers and 767 were pay stations. In Germany the number of telephone employees was not given, the same functionaries in most instances operating the telegraphs also, but in Austria 2,813 employees are mentioned as engaged specifically in telephonic service. The number of conversations was 132,977,492, with an additional 2,640,557 over interurban toll lines. The receipts were set down at 7,713,030 francs ($1,488,615), of which 3,401,552 francs ($656,500) came from exchange subscribers. In Hungary the whole telephonic exploitation is practically by the State, but 1 private exchange with 39 subscribers and 29,200 conversations being included. The Government installations included 76 exchanges with

3,013 kilometers (1,872 miles) of line, of which 292 kilometers (181 miles) were underground, and a total wire circuit of 89,299 kilometers (55,488 miles). There were 23,330 substations, of which 21,617 were those of subscribers, and 932 were pay stations. The number of conversations was 53,999,989, with an additional 641,835 interurban conversations. The total receipts reported were 3,846,287 francs ($742,333), of which 2,928,599 francs ($565,220) came from regular exchange operations and the rest from toll line work.

Belgium.—In Belgium the telephonic service is entirely in the hands of the State. Seventeen exchanges were reported, with a total length of circuit connected of 87,635 kilometers (54,454 miles). There were 138 interurban circuits, with 18,396 kilometers (11,437 miles) of wire. The number of substations was 21,984, of which 21,741 were subscribers' and 110 were pay stations. The total number of employees reported specifically for the telephone systems was 593, of whom 241 were linemen, etc., and 258 telephonists. The total number of telephonic conversations was 44,013,205, and of interurban talks 875,089. The total receipts were 5,504,721 francs ($1,062,411), of which 4,385,270 francs ($846,357) were from telephone subscribers. The direct expenses of the current year were set down at 4,520,740 francs ($872,502), of which 1,727,000 francs ($333,311) were for personnel and 2,793,740 francs ($539,191) for material. Up to the year 1903 telephone stamps were employed by the administration for the franking of communications between the public offices, but their use was discontinued in that year. There has been considerable development in the use of combination telegraphic and telephonic circuits, based upon the Van Rysselberghe system, which originated in Belgium, and which, with modifications or elaborations, has been somewhat extensively used in the United States. There has also been considerable use made of a combined telephone and telegraph service.

Holland.—In Holland, as in Great Britain, the development of the telephone has been carried on by three methods—namely, private enterprise, exploitation by the State, and municipal ownership. The development by the State is relatively small, and during the year under report included only 315 stations on 175 interurban circuits, with 22,437 kilometers (13,941 miles) of wire, and no regular separate exchanges, although 260 employees are specifically reported for the telephonic administration. The number of conversations over the Government lines, wholly interurban, was 1,227,784. There were 38 exchanges carried on by private companies. These, like the municipal networks, have a concession from the State for an area limited within a given circle, having a radius of 5 kilometers (3 miles), the limitations in each case being imposed by Government authority. These 38 exchange systems, whose mileage of circuit was not reported, included 10,250 substations, of which 93 were pay stations and the others subscribers'. Over this network 11,243,541 conversations were exchanged. The systems under municipal ownership were reported as numbering 22, with 48,826 kilometers (30,339 miles) of circuit distributed over 1,107 kilometers (688 miles) of line. Of the 16,005 substations thus connected, 15,895 were subscribers' and 110 pay stations. The staff included 480 individuals, of whom 409 were wage-earners, the corresponding total figures for the private plants being 273 employees, of whom 227 were wage-earners. The municipal system was utilized for 33,020,423 conversations. As neither the private companies nor the municipal exchanges reported any interurban or territorial work, and as the Government system reported no urban work and 1,227,784 interurban conversations, the division of the service is clearly marked, the Government evidently limiting itself to work which in the United States is generally spoken of as "long distance" or "toll line" business. No figures of earnings or expenses were reported by the companies or municipalities, but the Government reported receipts of 892,356 francs ($172,225) and expenses of 1,264,067 francs ($243,965).

Denmark.—In Denmark the division of service corresponds somewhat to that observed in Holland. The 80 exchanges reported were all conducted by companies. These companies operated 10,886 kilometers (6,764 miles) of city line, with 103,124 kilometers (64,078 miles) of wire circuit, and also 459 interurban circuits, with 26,339 kilometers (16,366 miles) of wire. Of the 42,594 substations reported, 41,194 were subscribers' and 960, including 473 described as automatic, pay stations. The administration included 1,920 persons, of whom 1,321 were telephonists and 445, linemen, etc. During the year 75,406,000 conversations were exchanged, with an additional 5,048,000 interurban talks. The income was 4,775,390 francs ($921,650), and the expenses 1,501,776 francs ($289,843). The expense and construction account up to the year was 19,922,038 francs ($3,844,953), but the construction account for the year under report was not given. The Government service, which embraced 32 interurban and long distance circuits, with 6,515 kilometers (4,048 miles) of wire and 646 stations, reported 377,649 telephone-telegrams and 567,000 interurban or long distance talks. The receipts were given as 544,247 francs ($105,040), but no expense account was attached.

Spain.—In Spain part of the telephonic traffic was under the direct control of the Government, which reported 14 exchanges, with 389 stations connected, 683 kilometers (424 miles) of line, and 3,015 kilometers

(1,873 miles) of circuit, and 12 interurban circuits, with 680 kilometers (423 miles) of wire. The only business reported over this system was 2,703 long distance messages, but at the same time the total receipts returned were 883,498 francs ($170,515). This amount, however, included royalty accepted by the State from private companies and from individuals operating private lines. The most important of the private exchanges in Spain were naturally those in the large cities, such as Madrid, Barcelona, Valencia, and Bilbao, and the total number of systems in this class was returned as 46, with 54 exchanges and 15,018 subscribers; but no detailed figures were forthcoming as to the number of conversations, receipts, or expenses. It will be observed in Table 41 that the total number of subscribers in Spain at the end of 1904 was 16,000, but as the number for the year 1902–3 was 15,433 the service was apparently at a standstill. The royalty paid to the State included 751,066 francs ($144,956) from the urban companies. The separate or individual circuits reported as existing between cities and factories, farms, cattle ranches, etc. numbered 1,096, with 7,672 kilometers (4,767 miles) of wire and 2,138 telephones, and paid 48,360 francs ($9,333) into the treasury of the State. The Government had constructed and was operating several long distance circuits, more particularly for its own uses, as between Madrid and the summer residence of the court at San Sebastian.

Italy.—The development of the telephone in Italy has been almost wholly in the hands of private companies, which reported 88 exchange systems, 5,478 kilometers (3,404 miles) of line, and 47,567 kilometers (29,613 miles) of wire circuit. Of the 23,331 substations also reported, 22,961 were subscribers' and 282 pay stations. The personnel of the system included 1,373 employees, of whom 489 were linemen, etc., and 648 telephonists. The number of conversations was 65,359,073, to which should be added 412,530 long distance messages. The total receipts were 3,428,732 francs ($661,745), of which 3,205,854 francs ($618,730) were from subscriptions. The expense account shows a total of 1,367,346 francs ($263,898), of which 628,562 francs ($127,598) were for material, and 738,784 francs ($142,585) for salaries, wages, etc. No item is given as to fixed charges, dividends, etc. The State telephone service was apparently a negligible quantity, including only 1,263 miles of long distance line, with 8 stations, over which 154,920 long distance messages were exchanged. The income of the State from telephony was 152,753 francs ($29,481), derived entirely from royalty in the shape of *taxes des conversations*.

Russia.—Telephony in Russia is operated both by the State and by private enterprise. The Government system preponderates. There were reported 93 Government exchanges, with 7,232 kilometers (4,494 miles) of line and 56,053 kilometers (34,830 miles) of wire circuit, supplemented by 29 interurban circuits, with 24,974 kilometers (15,518 miles) of wire. These exchanges had 24,974 substations, of which 24,706 were subscribers' and 112 pay stations. The administration included 1,368 employees, of whom 493 were linemen, etc., and 724 were telephonists. Over this system a business of 121,279,887 conversations and 1,609,073 interurban talks was exchanged. The total receipts were 8,279,128 francs ($1,597,872), of which 6,806,856 francs ($1,313,723) were from subscriptions. The item of miscellaneous receipts included 1,389,584 francs ($268,190), in which may possibly be included license royalties paid by the private companies to the State. The expenses are set down as 3,114,736 francs ($601,144), of which 1,020,380 francs ($196,933) were for material and 2,094,356 francs ($404,211) for salaries, wages, etc. The total expenses of the system prior to the year of the report was placed at 15,086,094 francs ($2,911,616), but no allowance was made in the expenses for interest on such investment. The private development of the telephone in Russia included 11 exchanges, with 1,060 kilometers (659 miles) of line and 69,063 kilometers (42,914 miles) of circuit. There were connected 23,802 substations and 7 public pay stations. The business done over the systems included 49,726,185 telephonic conversations. No report was made of receipts or expenditures.

France.—The returns for France were entirely the figures of the Government and included 3,221 exchange systems. These had 24,948 kilometers (15,502 miles) of line, of which 18,839 kilometers (11,706 miles) were overhead and 6,109 kilometers (3,796 miles) underground. This included 427,527 kilometers (265,652 miles) of wire circuit, of which a very large proportion—328,404 kilometers (204,060 miles)—was underground, one-third being held in reserve and two-thirds being in active service. In addition there were 5,172 interurban circuits, with 210,052 kilometers (130,520 miles) of wire. The number of substations connected was 117,302, of which 108,946 were subscribers', 5,129 public pay stations, and 3,227 telephones at central exchanges. The personnel of the system included 6,056 employees, of whom 1,569 were linemen, etc., and 3,741, telephonists. During the year the business done amounted to 191,315,764 conversations within urban limits and 11,768,453 interurban conversations. No figures of expenses are given, as these are included with those of the posts and telegraphs under the administration of the one officer of the State. Most of the receipts—20,779,055 francs ($4,010,358)—came from subscriptions, while the miscellaneous receipts were massed as 7,157,174 francs ($1,381,335).

Switzerland.—In Switzerland the telephone service is in the hands of the Federal Government, and is intimately associated with the telegraphic administration.

The number of exchange systems in 1902–3 was reported as 340, with 15,328 kilometers (9,524 miles) of line and 184,596 kilometers (114,702 miles) of wire circuit in city service, supplemented by 698 kilometers (434 miles) in interurban service, with 20,058 kilometers (12,463 miles) of wire. In the cities 140,995 kilometers (87,610 miles), or 75.9 per cent, of the total wire length in service was underground. This disproportion was due apparently, however, to the fact that the metallic or double circuits were counted twice. The same statement applies also to a large part of the interurban service. Connected with the lines were 49,731 stations, of which 48,408 were those of subscribers, 983 were public pay stations, and 340 telephones at central offices. The public pay stations included 867 "communal stations." The personnel of the service was given as 1,279 employees, of whom 496 were linemen, etc., and 467 were telephonists. The number of telephonists did not include 601 operators who were reported as exercising also some other "profession." The administrative staff included 90 chiefs of staff, etc., in addition to whom there were 42 functionaries of the telegraph system whose duties also included responsibility for the telephonic work. Besides these no higher officials were reported as in charge of the telephone system. The service done over the system amounted to 25,503,421 conversations within the city limits, and 5,518,419 interurban conversations, with which were included also 73,806 international conversations, as with France, Italy, and Germany. The receipts of the service were returned as 6,385,651 francs ($1,232,431), of which 2,739,180 francs ($528,862) were directly from subscriptions and 1,257,620 francs ($242,721) from pay station and other service. The receipts from interurban work appear to have been very high, the *taxes des conversations* under this head being set down as 2,024,789 francs ($390,784). The expenses were returned as 7,651,202 francs ($1,476,682), of which 5,657,832 francs ($1,091,962) were for material and 1,993,370 francs ($384,720) for the personnel. The large outlay in construction is explained by the fact that it embraced over 3,000,000 francs ($599,000) for interest and sinking fund and the cost of creating the system up to the year in question. With regard to the receipts, it would appear that part of such earnings by the telephone goes into the telegraph account as the earnings of the telephone-telegraph system.

Norway.—The figures for the exploitation of the telephone in Norway are not all for the same periods, and those relative to the work of the State belong to the budget year 1903–4. The service is carried on in part by the State and very largely by private companies. The State administration of the telephone is intimately associated with that of the telegraph, and it is difficult, therefore, to separate clearly all the telephonic figures. The number of the State systems was returned as 25, some of which were established by the Government and others acquired from private parties. The length of line was 631 kilometers (392 miles), with 51,000 kilometers (31,690 miles) of wire circuit in city limits. In addition to this 233 interurban circuits were reported, with a line length of 8,069 kilometers (5,014 miles), and 29,269 kilometers (18,187 miles) of wire circuit, almost entirely overhead. Connected by the system were 16,846 stations, of which 15,580 were those of subscribers, 990 public pay stations, and 276 located at central exchanges; 243 of these latter stations were also telegraphic offices. The public pay stations were also of a telegraphic character, it being possible to communicate telegrams from 749 of them, while 147 were equipped with telegraphic apparatus. Subject to the reservation already noted, the personnel of the telephone system included apparently 25 chiefs of staff, 5 engineers, 20 superintendents of equipment, 141 linemen, etc., and 218 telephonists. The business done over the systems amounted to 42,661,560 conversations within city limits and 2,081,000 interurban talks, the limit of time being 3 minutes, as compared with the limit of 5 minutes generally imposed by the Norwegian private companies. No separate figures of receipts or expenses were furnished by the State, for the reason that the telephone service is considered an integral part of the telegraph administration. Private enterprise in Norway was credited with the creation of 200 telephone exchange networks, with 8,127 kilometers (5,050 miles) of line and 36,260 kilometers (22,531 miles) of wire circuit. The number of interurban circuits is not reported, but the length of line is given as 12,189 kilometers (7,574 miles) and the length of wire circuit as 21,449 kilometers (13,328 miles). There were reported 22,901 stations, of which 20,976 were subscribers', 1,366 public pay stations, and 559 central office telephones. The personnel of the service included 207 chiefs of staff, 8 engineers, 205 superintendents of construction, linemen, etc., 234 laborers, and 776 telephonists. The number of conversations carried on over the systems in city limits was 43,714,342, of which 42,821,674 were subscribers' talks. The number of interurban conversations was 2,597,517. The receipts of the systems were returned as 1,370,773 francs ($264,559), of which 1,114,628 francs ($215,123) were for subscriptions, and 165,685 francs ($31,977) from pay station service. The expenses were returned as 1,225,376 francs ($236,498), 676,695 francs ($130,602) being for material and 548,681 francs ($105,895) for personnel. The item for material was divided into about two-thirds for maintenance and one-third for construction, etc. The total cost of the service up to the year of the report was 7,117,935 francs ($1,373,761).

Sweden.—The telephone in Sweden is largely in the hands of the State, but is also operated by private stock companies and by cooperative organizations (*sociétés mutuelles des habitants*), which are closely analogous to the mutual cooperative systems in the United States enumerated elsewhere in this report. The figures are of more than usual interest on account of the extraordinary development in one or two of the larger cities. The service of the State included 152 exchanges or exchange systems, with 75,558 kilometers (46,949 miles) of wire circuit supplemented by 1,402 interurban lines, with a line length of 21,222 kilometers (13,187 miles) and a wire length of 63,698 kilometers (39,580 miles). In the wire lengths the metallic circuits are apparently given twice over. There were 68,970 telephonic stations, including 954 public pay stations, and the business transactions over this system included 171,392,644 messages within urban limits, and 6,470,298 interurban or long distance talks of a duration of three minutes each. The personnel of the system included 84 officials at the head of the department, with 200 superintendents of exchanges and assistants, 27 engineers, 300 superintendents and foremen of construction, 900 linemen, etc., and 2,200 telephonists. Most of the telephonists are women. With regard to the remainder of the personnel, the telegraphic and telephonic services are so closely united that it is difficult to distinguish between the two sets of employees.

This difficulty also applies with regard to other data. The total of receipts was not given, but an amount of 4,665,549 francs ($900,451) from subscriptions to city exchanges and 2,807,504 francs ($541,848) as *taxes des conversations* was reported. This included also fees for local use of pay stations, so that the amount for interurban conversations was not reported separately. No expenses were set down for the separate operation of the telephone, but it was reported that the investment or expenses up to the current year had amounted to the gross sum of 37,223,150 francs ($7,184,068). The exploitation by private companies included only 5 exchanges, 2 of which were in cities. These were virtually the systems of the Stockholm General Telephone Company, that reported 35,165 telephones, of which all but 199 were those of subscribers. The system included 46,810 kilometers (29,086 miles) of wire circuit in city limits and 15,208 kilometers (9,450 miles) of interurban circuits. No figures were reported as to personnel, traffic done, receipts, expenses, or total investment. The mutual systems numbered 23, with 3,327 kilometers (2,067 miles) of wire circuit in the urban networks and 491 kilometers (305 miles) of interurban circuits. Connected with these lines were 1,106 stations, of which 1,069 were those of subscribers. No figures were reported as to the other items of investment, income or expenses, personnel, or traffic.

During the parliamentary investigation in Canada during 1904 it was stated by Mr. H. L. Webb, the English expert, that in Stockholm and the surrounding districts the State systems had 11,000 stations, and the company's system 34,000 or 35,000, and that he doubted whether, out of the 11,000, there were more than 2,000 or 3,000 that were on the State systems only, the remainder being duplicates of the company's installations.

Great Britain and Ireland.—The official statistics for Great Britain and Ireland were all returned as of the financial year 1903–4, and represent exploitation by the State. No figures were given for the vastly larger systems operated by the National Telephone Company under its license from the Government. The figures included in the Berne statistics were those taken from the report of the Postmaster-General as the official in charge of the operation of the service. The number of Government telephone stations reported was 23,672, of which 22,506 were those of subscribers, 655 were public pay stations, and 511 were in central offices. The subscribers' stations were very largely grouped in London, 15,632 being in that city and only 6,874 in other cities and towns. The telephone trunk lines constituted the basis of Government service and included for 1903–4 1,418 circuits, with 102,799 miles of wire, over which 13,467,975 calls or conversations were exchanged.

The revenue from this service was £325,525 ($1,584,167), and the capital expended £2,200,024 ($10,706,417). These trunk lines have been gradually taken over by the Government from the National Telephone Company, the original transfer beginning about 1892 and ending in 1896. The National Telephone Exchange Company, which has an exchange system in practically every community of any size in Great Britain and Ireland, is to be credited with the bulk of the telephone development there, the exception being that included in a few municipal exchanges. The British Postmaster-General during the present year has come to an agreement with the National Telephone Company to take over its business and buy its plant as from December 31, 1911. The entire telephonic system of the country will therefore be under direct State control. The price to be paid for the business is to be settled by arbitration, and all that is to be paid is the fair market value of the plant and works of the company. The purchase is to be determined on what are known in England as "tramway terms," that is to say, no payment is to be made in respect to compulsory purchase, good will, or past or future profits. Exceptions are made with regard to the private wire business of the company, which can be carried on without the Postmaster-General's license, and a very few cases where the company's license has, for reasons of benefit to the public, been extended beyond 1911. Three-fourths of the whole purchase money may, at the option of the Government, be paid by way of annuities for a term not exceeding twenty years. The Postmaster-General is also clothed with power enabling him to object to the purchase of any plant unsuitable for the carrying on of business.

In order to insure the efficiency of the service during the company's continuance in possession and operation, it is bound by agreement to allow intercommunication without additional charges between the systems of the Government and those of the company, and is forbidden to show any favor or preference as between subscribers. While the minimum and maximum rates that the company can charge are fixed, it is provided that, if on complaint and on full inquiry the company is shown to be giving inefficient service in any district or community, the Postmaster-General may take over the company's business there at once, without any payment or allowance for good will. The amount of money involved in this wholesale transaction can not be determined closely, but it may be stated that the company has a share capital of about $22,500,000, with debentures amounting to nearly $20,000,000 more. The company has been operating on a reasonably profitable basis, paying an average of 5 per cent on the stock. Owing to the close association of the telegraph and telephone systems in England as operated under Government control, it is difficult to determine the profit, if any, that is made by the systems under State control. The deficit on the operation of the telegraph service as a whole in 1903 was £601,711 ($2,928,227), and in 1904 was £983,681 ($4,787,084).

In the city of London, which has by far the largest system in England, and includes an area of 640 square miles, the National Telephone Company had over 60 exchanges, and the post office 17 or 18. Within that area at the end of 1904 there were 93,598 subscribers. On March 1, 1904, the Government service included 10 exchanges, with 15,632 subscribers. Of these, 10,541 were connected with the main office, called "central," and a second exchange of the same character having become necessary, one was under construction, with a maximum capacity of 18,000 lines. The length of the underground pipe for circuits laid in the London area was 1,146 miles and, including 32,248 miles allotted for the use of the National Telephone Company on rental terms pending the transfer of the company's system to the post office, cables containing 125,717 miles of wire had been provided.

The report of the Postmaster-General states that the sum represented as rentals of the post office provincial telephone exchange circuits and of private subscribers' wires was £206,786 ($1,006,324), and it is also noted that the amount of royalty received during the year from the National Telephone Company was £169,853 ($826,590), the amount received from other licensees being £3,266 ($15,894). An interesting part of the work of the Government service has consisted in connecting up post offices with the trunk line systems, thus giving telephone service to places which previously had none, and in establishing call office systems in rural districts with the aid of a public telegraph circuit, with a view to ascertaining what demand there is for telephonic facilities between market towns and the surrounding villages. Three places had been selected for this latter experiment—one each in England, Scotland, and Ireland—but up to the time of the report the system had been little used by the public and the receipts had not even covered the cost of attendance and maintenance.

The report of the Postmaster-General states that of the sum of £3,000,000 ($14,599,500), authorized by a telegraph act of the year for the development of the telephone systems of the country, £1,300,000 ($6,326,450) would be required for the development of the wire systems and about £1,700,000 ($8,273,050) for the development of the exchange system in London and the provinces. The Government work connected with the trunk line system and the exchange system has been referred to above. In addition to this work, considerable outlay has been required in connection with communication between England and the continent. For some years past England and France have been connected by submarine telephone cables, and the service was continued during 1904. Telephone communication was established between London and Brussels in 1903. The service was extended later to certain provincial centers in England and Belgium during the same year, and at the present time circuits are working satisfactorily between London and Holland. Owing to the greater distance and length of circuit, the results were such as to show that it was not yet entirely practicable to construct a cable line which would enable such direct telephonic communication to be permanently established and satisfactorily maintained.

The remaining telephone development has been attempted by a few municipalities under a special license from the Postmaster-General. When the law which authorized British municipalities to borrow money to establish local telephone systems was passed in August, 1899, it was supposed that a large number of local bodies would take licenses for such a purpose. But up to the time of the report only six municipalities had established systems in the six years, and one of the exchanges—that at Tunbridge Wells—after an unprofitable life, had gone out of existence. The other places in which these exchanges existed were Glasgow, Portsmouth, Swansea, Brighton, and Hull—large and important communities; but the general impression to be derived from the evidence and statements with regard to the subject would lead to the inference that such a development had ceased, and the Postmaster-General's report for 1903–4 showed that he had not granted any licenses during that year for the establishment of municipal exchange systems. Aside from the uncertainty of the municipal results attained, the taking over of the entire telephonic service by the Government in 1911 may have operated strongly to check any movement in the direction of the establishment of such systems as part of the general scheme of municipal ownership of public utilities. It is stated that the 5 exchanges referred to include approximately 10,000 telephones not duplicated by the other systems, and that for the establishment of these systems a gross sum of £600,000 ($2,919,900) has been spent. With regard to the Glasgow system, which was based upon a method of operation abandoned some years ago in the United States as inadequate, Mr. Webb in his evidence before the Canadian parliamentary committee testified as follows:

> They have a capital of something over £350,000 ($1,703,275) and a very large proportion of their assets are practically worthless. According to the modern standard of telephony, practically the whole exchange equipment, the whole of the subscribers' station equipment, is obsolete, and if the systems were taken over by practical telephone people, it would have to be largely reconstructed. Therefore there is a capital account of £350,000 ($1,703,275), out of which you can wipe practically one-third right away.

British India.—Telephone development in British India, which has been considerable, is largely in the hands of the State. Under State exploitation there were reported for the year 1903, 524 exchanges and exchange systems, with 1,617 stations, 1,802 kilometers (1,120 miles) of line, and 8,209 kilometers (5,101 miles) of circuit. The income reported was 313,107 francs ($60,430). It is evident that these data are very incomplete. In addition to this there were the exchanges of the Bombay Telephone Company, the Bengal Telephone Company, and the Oriental Telephone and Electric Company, all of which included apparently 3,229 stations and had an income of 823,171 francs ($158,872).

Canada.—The development of the telephone in Canada has been almost entirely in the hands of private enterprise, as represented by the Bell Telephone Company of Canada, and in recent years by a few opposition systems. The Bell telephone systems operated by the company included in 1904, 475 exchanges and 789 agencies, with 66,160 telephone stations. The gross revenue from all sources was reported as $2,988,990. The capitalization of the system was $9,916,960, of which $7,916,960 were common stock and $2,000,000 were bonds. Making a further subdivision, the total exchange capital was reported as $6,465,854, the total line capital, $2,166,176, and the total real estate capital, $1,284,930. The system included 32,218 miles of wire on the long distance circuits, and the separate long distance revenue included in the above was $762,000.

Japan.—Among the Oriental peoples the Japanese exemplify the readiest adoption of the telephone, and the system in their country is already well established and rapidly growing. For the year 1903–4 there were reported 27 exchange systems under State exploitation, of which 3 were in Korea. These included 2,800 kilometers (1,740 miles) of line, with 170,942 kilometers (106,218 miles) of circuit, and 131 interurban circuits, with 12,033 kilometers (7,477 miles) of wire. With these lines there were connected 37,077 stations; of which 329 were public pay stations, 4 of which were in Korea; and of the 36,714 subscribers' stations included, 594 were in Korea. No separate figures were given for the personnel, owing to the common operation of the post, telegraphs, and telephones by the Government. The business transacted included 132,341,271 conversations on exchange systems and 1,203,295 interurban talks. The receipts amounted to 6,692,247 francs ($1,291,604). No full report was made of expenses, but the separate charge to the system, almost entirely for materials, was reported as 671,389 francs ($129,578). The total expended on the establishment up to the time of the report was 32,633,101 francs ($6,298,188).

Telephone rates.—Tabular statements, based upon those in the report of the evidence given before the Canadian parliamentary committee of inquiry into telephony, are furnished herewith, giving a synopsis of telephone rates in continental Europe, and in one instance the long distance rates in the United States and Canada. These statements summarize the general conditions, but require explanation and further data in regard to some features.

Telephone rates in continental Europe.

Country.	Entrance fee.	Subscription.	Annual subscription for second and subsequent connections.	Remarks.
Austria	$20.28	$20.28	$20.28	
		40.00		Vienna.
Bavaria		36.53	18.27	
Belgium		48.25		Brussels.
		38.60		Charleroi.
		32.81		Small towns, annual contract.
		28.95		Small towns, three years.
Bulgaria		38.96		First year.
		29.22		Second and subsequent years.
Denmark		40.56	32.46	Copenhagen covers the whole island of Zealand, 80 miles by 60.
		9.41 21.60		Smaller towns.
Finland	$48.70	13.64		Helsingfors Cooperative Exchange.
	$48.70	11.68		Abo.
	$38.96	9.74		33 cooperative exchanges.
		15.57		Companies.
		23.38		Companies.
France	Cost of telephone.	80.00		Paris subscribers must also buy their telephones and pay for the cost of connection.
		58.44		Lyon.
	$2.66 per $\frac{1}{10}$ mile and cost of telephone.	38.96		Other towns over 25,000 inhabitants.
		29.22		Other towns under 2,500 inhabitants.
Germany		24.30		Over 20,000 telephones.
		21.87		Under 20,000 telephones.
		18.23		Under 5,000 telephones.
		14.58		Under 1,000 telephones, with following additional charges: $4.86 first 500 messages; $3.65 per 500 up to 1,500 messages; $2.43 per 500 up to 5,000 messages; $2.43 for unlimited calls over 5,000.
			45.00	Berlin.
			40.00	Hamburg.
Hungary		60.88		Budapest.
		24.35		Other towns.
Holland	$10.00	46.00		Hotels, Rotterdam and Amsterdam.
	$10.00	36.00		Business and residence, Rotterdam and Amsterdam.
		44.00		The Hague.
		16.23 24.14		The Netherlands Bell Telephone Company operating 13 towns.
		14.08		11 towns.
		14.08		The Zutphen and the Maastricht Telephone companies.
		12.08		2 towns.
Italy		26.89		Rome, cooperative exchange.
		32.75		Rome Company's exchange.
		38.96		Naples, Milan, Palermo, Genoa, Venice, and Turin.
Italy		$31.18		Turin rate for residence, doctors, and druggists.
		31.18 38.96		Florence, Bologna, Leghorn.
		27.27 35.05		Messina, Padua, Brescia.
		29.22		Verona, Bari, Parma, Vicenza.
		13.64 23.38		Other towns.
Luxemburg		15.57		Includes free intercommunication between all points in the Grand Duchy, 44 miles by 30.
Monaco	$2.66 per $\frac{1}{10}$ mile and cost of telephone.	29.22		
Norway		21.62	$16.23	Christiania.
			7.11	Christiania, second telephone on same line.
		12.18	6.09	Trondhjem municipal system.
		13.54		Christiansand.
		10.74		Christiansand, suburbs.
	Cost of telephone.	12.08 17.57		Christiansand.
		16.23		Fredrikstad, business.
		13.34		Fredrikstad, residences.
	$12.18	18.31		Bergen.
		8.09		Grimstad, one telephone.
		12.08		Grimstad, two telephones.
		16.23		Grimstad, three telephones.
	$13.54	8.09		Horten.
	Cost of line and instruments.	6.84 13.54		Other towns.
Portugal		36.59	27.39	
Roumania	$29.22	38.96		Covers 1,000 calls; $3.90 per 100 afterwards.
Spain		27.27 58.44		According to population. Hotels, clubs, railway stations, public places, etc., treble rates charged.
Sweden	$13.54	26.80	21.62	Company's charge for a radius of 40 miles.
	$13.54	21.62	16.21	State charge for a radius of 40 miles.
	$13.54	16.21		Company's charge per phone for 3 phones on same line in 40 miles radius.
	$2.71	9.68		Company's charge for service limited to 400 calls per year; excess calls charged 2½ cents each.
	Cost of line and instruments.	6.09 16.23		Cooperative.
Switzerland		19.44		First year, and 1 cent a message.
		13.60		Second year, and 1 cent a message.
		7.80		Third year, and subsequent years, 1 cent a message; messages average 535 per subscriber per annum.
Wurtemburg		24.35	12.18	

Long distance rates in the United States, Canada, and European countries.

COUNTRY.	DISTANCE IN MILES.									
	20	40	80	120	160	200	240	280	400	600
United States[1] Canada[1]	$0.12	$0.24	$0.48	$0.72	$0.96	$1.20	$1.44	$1.68	$2.40	$3.60
Great Britain[2]	0.06	0.12	0.24	0.36	0.48	0.60	0.72	0.84	1.20	1.80
Austria	0.12	0.20	0.28	0.40	0.40	0.40	0.40	0.40	0.60	......
Bavaria	0.10	0.10	0.24	0.24	0.24	0.24	0.24	0.48	......	......
Belgium	Free.	0.20	0.20	0.20	0.20	0.58	......	......	......	......
Denmark	Free.	Free.	0.26½	0.40	......	......	......	0.53	0.53	......
Finland	0.02½	0.02½	0.04½	0.06	0.09	0.11	0.13	0.15	......	......
France	0.10	0.10	0.20	0.20	0.29	0.38	0.38	0.48	0.66	0.96
Germany	0.06	0.12	0.24	0.24	0.24	0.24	0.24	0.24	0.36	0.36
Holland	0.20	0.20	......	......	......	......	......	......	......	......
Luxemburg[3]	......	......	......	......	......	......	......	......	......	......
Norway	0.07	0.07	0.07	0.07	0.13	0.13	0.13	0.13	0.44	......
Roumania	0.26	0.26	0.48	0.48	0.66	0.86	0.86	1.04	......	......
Spain	0.13	0.13	0.24	0.24	0.34	0.43	0.43	0.53	0.72	1.00
Sweden	Free.	Free.	0.08	0.08	0.13	0.13	0.13	0.13	0.20	0.27
Switzerland	0.06	0.10	0.15	0.15	0.15	0.15	0.15	0.84	1.17	1.68
Wurtemburg	0.10	0.10	0.10	0.10	0.10	......	......	......	......	......

[1] Half rate at night, 6 p. m. to 6 a. m.
[2] Double period allowed for day rate at night.
[3] Local rate covers free intercommunication between all points.

Tariff rates for the London area.

	£	s.	d.	
I.—*Ordinary message rate service:*				
(a) Charges for connection with any exchange in the county of London within 2 miles of subscriber's premises.				
Annual subscription	5	0	0	($24.33)
Message fees— *One penny* for each call to a subscriber on any exchange in the county of London. *Two pence* for each call to a subscriber on any exchange outside the county of London.				
(b) Charges for connection with any exchange outside the county of London within 2 miles of the subscriber's premises.				
Annual subscription	4	0	0	($19.47)
Message fees— *One penny* for each call to a subscriber on the same exchange. *Two pence* for each call to a subscriber on any other exchange.				
The minimum yearly amount payable by each subscriber for message fees is	1	10	0	($7.30)
II.—*Party line message rate service:*				
Annual subscriptions—				
(a) For connection with any exchange except the Central Exchange by means of a line used by not more than two subscribers	3	0	0	($14.60)
(b) For connection with any exchange outside the county of London by means of a line used by not more than two subscribers	2	0	0	($9.73)
Subscriptions at party line rates can not be accepted from subscribers on the Central Exchange, or at the lower party line rate from subscribers on any exchange in the county of London.				
The above charges have reference to cases where the main circuit of a party line does not exceed 2 miles, and the spur circuit to each subscriber does not exceed 220 yards in length, otherwise there are additional charges mentioned under IV, below.				
Message fees for calls originated by party line subscribers will be the same as for calls by subscribers at the ordinary message rate, but the minimum yearly amount payable for message fees by each party line subscriber is	3	0	0	($14.60)
III.—*Unlimited service:*				
Annual subscription for connection with any exchange within 2 miles of the subscriber's premises, together with an unlimited number of calls—				
(a) For the first line	17	0	0	($82.73)
(b) For each additional line connecting any premises of the same subscriber with an exchange	14	0	0	($68.13)
IV.—*Additional annual charges:*				
(a) Where the premises of any subscriber at the ordinary message rate or at the unlimited service rate are more than 2 miles from the exchange, for every additional quarter of a mile or part thereof	1	5	0	($6.08)
(b) Where the main circuit of a party line exceeds 2 miles in length, for each quarter of a mile or part thereof in respect of each subscriber whose spur circuit issues from the main circuit at a point more than 2 miles from the exchange	0	10	0	($2.43)
(c) Where the spur circuit of a party line exceeds 220 yards in length, for each additional quarter of a mile or part thereof	1	5	0	($6.08)
V.—*Extension lines:*				
(a) For each extension line connecting two parts of the same premises of a subscriber, where the line is not more than 110 yards in length	1	10	0	($7.30)
(b) For each additional 110 yards of such a line	0	10	0	($2.43)
(c) For each extension line connecting separate premises of the same subscriber, and not more than a quarter of a mile in length	3	10	0	($17.03)
(d) For each additional quarter of a mile of such line	1	5	0	($6.08)
Extension lines are not provided in connection with party lines.				
VI.—*Call offices:*				
For each period of three minutes' conversation	0	0	2	($0.04)

As will be seen, the statement of rates in continental Europe is a digest of a great variety of rates, which it is almost impossible to reduce to uniformity. An exemplification of this fact is presented in the Government (post office) tariff for the city of London alone, in which three classes of service are dealt with. This statement does not exhaust the subject, however, as there is another, but similar, scale for subscription to the service of the National Telephone Company, and the rates applying elsewhere in England, Scotland, or Ireland are not included. The post office authorities have stated with regard to London that 90 per cent of their subscribers are on the message rate basis. This rate is, as is general throughout Europe, for a three minutes' use, whereas in the United States the five minute period, with consequent saving to the public, is universal.

The reserve with which the European rates as to telephone service should be interpreted is illustrated in the case of Sweden, a country often cited for its cheap telephone service. In Sweden there is a flat rate of the General Company for "starred" subscribers, or those having against their names in the telephone directory an asterisk, which indicates that they may be called free by message rate subscribers. In other words, a message rate subscriber calling a "starred" subscriber is not charged the message fee for that call. Such "starred" subscribers pay 100 kroner, equal to $26.80. There is, in addition, for unstarred subscribers a flat rate of 80 kroner, and a party line rate of 60 kroner ($16.08), in each case an entrance fee of 50 kroner ($13.40) being paid. An inside extension station costs 34 kroner ($9.11), and an outside extension line 40 kroner ($10.72) for the first 500 meters (about three-tenths of a mile), and in the same proportion for longer distances, with an additional installation fee of 10 kroner ($2.68). There is, moreover, a message rate for business purposes of 45 kroner ($12.06), with an installation charge, and a residence message rate subscription of 36 kroner ($9.65). As compared with the company rate in Stockholm, the maximum Government rate is 50 kroner ($13.40), but outside that city the Government charges higher rates. It should also be noted that in addition to the shorter time for a message—three minutes—the subscriber paying for 1,000 messages per quarter usually has that number allotted to him, and if he does not use them has no credit for the unused messages on the next quarter. The rate for extra messages is 2.7 cents above the 100 per quarter. Hence in view of the difference in the purchasing power of money in the United States and Sweden, the lower wages paid in Scandinavia, and other conditions bearing on the subject, the statements as to the great relative cheapness of telephony in Sweden do not appear to be justified.

With regard to the table of long distance rates it may be explained that various differences in practice exist which in certain ways modify the mere figures presented. In Great Britain, for example, no user is permitted to retain a trunk line for more than two consecutive periods, or six minutes in all, after which he must give way and await his turn again. No such restriction applies in the United States, owing, probably, to the more liberal provision of circuits. As to the conditions in Europe, the testimony of Mr. H. L. Webb before the Canadian committee may be quoted as follows:

The service which is given is very much more complete in this country (United States) than it is anywhere in Europe. In Europe you have to call by number. On the long distance even you have to call by number. If you get the number, you pay whether you get the man you want to speak to or not. In this country it is the practice to call by name, and, unless you get the person you want to speak to, you do not pay. This of course is a very great accommodation to the public, and it is a large element in determining the value of the service—the price that it is worth. Then on the continent of Europe the same trouble exists—that delay. The rates are very cheap, but you can not get service. There are so few lines in comparison to the traffic that practically through the busy hours of the day, up to late in the afternoon, the lines are blocked, and if you want to get a man promptly you pay what is called the "urgent rate," which is triple the ordinary rate. A very large proportion of the messages that are sent are sent as "urgent" and the senders pay triple rates, so that the rate that is quoted does not at all represent the actual conditions.

Telephonic telegrams.—A branch of telephonic work familiar in Europe, but not known to any extent in the United States, is that reported in the Berne statistics under the head of "*telegrammes-telephones,*" meaning, in general, messages transferred from the one set of wires to the other, so that a message can be telegraphed and then telephoned, or vice versa, from the receiving office to the subscriber's business address or place of residence. A special form of service, also included under this head, is that of requesting a correspondent to put himself in communication telephonically with the sender of the message or notice or with a third person. The telephonic delivery of the telegraph message is usually free, but sometimes a small fee is collected, and in some instances, if requested, the messages are on receipt carried to the destination by messenger. In Norway a special subscription, based upon a sliding scale, is assessed for the transmission of telegrams by telephone. Arriving telegrams are transmitted free to all telephone subscribers, with the condition that the copy of the message will be forwarded as soon as possible, but at the convenience of the bureau. Subjoined are the figures reported from several countries for "telegrams-telephones."

Germany sent 1,836,139, received 1,155,853; Austria sent 721,076, received 696,426; Belgium sent 931,897, received 660,529; Denmark sent 239,730, received 137,919; France sent 1,452,944, received 1,406,512; Great Britain, total 2,689,000; Hungary sent 83,604, received 81,320; Japan sent 204,353, received 83,228; Norway sent 184,114, received 150,399; Holland sent 287,755, received 184,190; Russia sent 41,549, received 33,225; Sweden sent 482,462, received 329,582; Switzerland sent 119,195, received 135,697.

TABLE 43.—ALL TELEPHONE SYSTEMS—SUMMARY,

	STATE OR TERRITORY.	Number of systems.	Miles of wire.	Subscribers.	MESSAGES OR TALKS DURING YEAR.		
					Total.	Local.	Long distance and toll.
1	United States	4,151	4,850,486	2,178,366	5,070,554,553	4,949,849,709	120,704,844
2	Alabama[1]	47	32,659	13,385	46,158,943	45,666,699	492,244
3	Arizona[1]	11	3,872	3,123	5,072,727	5,004,894	67,833
4	Arkansas[1]	76	24,190	15,879	36,716,883	35,941,937	774,946
5	California	18	144,392	103,629	178,284,400	175,856,160	2,428,240
6	Colorado	13	52,115	23,060	60,258,533	58,726,904	1,531,629
7	Connecticut	6	56,181	21,638	35,933,102	34,417,525	1,515,577
8	Delaware[1]	3	10,690	3,472	8,962,892	8,786,328	176,564
9	Florida[1]	25	16,503	7,990	18,906,002	18,740,316	165,686
10	Georgia	78	53,689	24,297	96,192,066	95,613,168	578,898
11	Idaho[1]	7	6,314	3,554	6,451,762	6,222,416	229,346
12	Illinois	381	420,665	206,313	541,161,932	535,744,349	5,417,583
13	Indian Territory	37	5,227	4,918	8,337,959	8,114,111	223,848
14	Indiana[1]	366	209,599	129,835	294,657,565	290,579,503	4,078,062
15	Iowa	411	135,112	114,260	193,054,738	189,756,644	3,298,094
16	Kansas[1]	172	52,349	39,743	58,699,143	57,644,004	1,055,139
17	Kentucky[1]	119	154,586	44,873	143,101,564	141,815,744	1,285,820
18	Louisiana[1]	15	49,368	17,060	68,083,915	67,608,308	475,607
19	Maine	27	25,435	12,609	21,923,915	21,028,890	895,025
20	Maryland[2]	20	97,137	27,696	62,019,081	60,734,287	1,284,794
21	Massachusetts	10	257,461	87,767	183,115,320	173,300,896	9,814,424
22	Michigan	110	196,520	91,318	237,695,112	233,911,515	3,783,597
23	Minnesota	151	136,356	58,509	113,124,262	110,586,037	2,538,225
24	Mississippi[1]	35	29,453	14,742	60,414,961	59,903,306	511,655
25	Missouri	317	167,288	88,776	242,309,227	239,356,737	2,952,490
26	Montana[1]	6	8,517	5,099	11,352,976	11,105,729	247,247
27	Nebraska	106	52,711	32,531	73,227,030	71,992,686	1,234,344
28	Nevada[1]	8	1,394	1,113	1,409,134	1,363,082	46,052
29	New Hampshire	16	18,390	9,044	16,987,012	16,222,808	764,204
30	New Jersey[1]	28	136,617	41,265	56,171,223	51,388,176	4,783,047
31	New Mexico[1]	12	3,283	2,427	4,297,920	4,261,660	36,260
32	New York	267	622,908	222,520	360,098,123	339,731,099	20,367,024
33	North Carolina[1]	83	24,680	15,632	36,485,398	36,039,272	446,126
34	North Dakota[1]	32	9,532	6,321	14,106,733	13,754,186	352,547
35	Ohio	285	514,634	213,234	558,707,801	547,238,743	11,469,058
36	Oklahoma[1]	24	16,186	9,972	23,329,668	22,869,692	459,976
37	Oregon[1]	21	29,493	20,287	35,777,238	35,253,710	523,528
38	Pennsylvania	97	501,418	162,277	493,617,718	473,208,097	20,409,621
39	South Carolina[1]	42	18,621	10,014	23,893,914	23,507,281	386,633
40	South Dakota[1]	54	10,785	9,650	17,919,604	17,374,274	545,330
41	Tennessee	43	86,195	35,459	128,274,719	127,209,768	1,064,951
42	Texas	169	140,483	62,183	167,079,014	161,865,704	5,213,310
43	Utah	5	9,866	5,380	11,755,130	11,477,368	277,762
44	Vermont	37	16,363	10,990	19,075,847	18,541,214	534,633
45	Virginia[1]	87	44,672	23,242	65,494,626	64,719,606	775,020
46	Washington[1]	4	43,027	30,495	64,623,982	63,868,882	755,100
47	West Virginia[1]	83	56,384	20,805	41,605,891	40,176,425	1,429,466
48	Wisconsin	183	109,536	58,584	101,594,728	98,980,462	2,614,266
49	All other states[4]	4	37,630	11,396	23,033,120	22,639,107	394,013

[1] Contains data for system credited to and operating in an adjoining state.

[3] Deficit.

BY STATES AND TERRITORIES: 1902.

Stations or telephones of all kinds.	Number of public exchanges.	Switchboards of all kinds.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		Total revenue.	Total expenses.	Net surplus.	
			Number.	Salaries.	Average number.	Wages.				
2,315,297	10,361	10,896	14,124	$9,885,886	64,628	$26,369,735	$86,825,536	$80,147,490	$6,678,046	1
14,077	69	72	65	39,081	309	92,200	528,821	448,640	80,181	2
3,259	30	30	29	12,458	73	39,128	114,480	76,442	38,038	3
16,892	123	125	41	28,230	438	135,049	565,024	439,872	125,152	4
106,574	376	376	654	329,875	2,990	1,572,218	4,091,076	3,927,990	163,086	5
24,533	96	96	136	130,312	960	467,210	1,137,263	1,032,385	104,878	6
22,494	44	46	124	113,179	640	344,727	1,328,186	1,305,808	22,378	7
4,293	21	21	36	22,288	173	81,623	189,846	208,508	[2]18,662	8
8,216	38	40	40	26,858	150	45,244	212,099	185,183	26,916	9
25,490	113	120	275	182,887	564	166,545	863,033	761,817	101,216	10
3,862	33	34	65	22,311	170	100,656	178,282	181,597	[2]3,315	11
211,187	912	945	1,415	959,193	6,066	2,301,144	7,308,885	6,851,241	457,644	12
5,331	50	55	27	17,530	139	43,905	164,142	103,888	60,254	13
132,489	621	650	476	230,339	2,860	858,711	2,816,509	2,411,573	404,936	14
120,017	710	729	341	178,792	1,909	610,039	1,962,362	1,551,559	410,803	15
40,972	259	266	141	73,687	820	227,552	877,783	627,779	250,004	16
46,266	203	204	250	154,229	1,483	462,433	1,377,441	1,228,675	148,766	17
17,509	60	62	88	64,564	601	214,004	803,399	718,544	84,855	18
14,045	112	112	55	31,730	357	173,986	597,204	568,821	28,383	19
32,090	93	95	291	214,766	1,328	629,351	1,517,102	1,444,055	73,047	20
96,512	233	235	1,155	1,182,216	3,524	1,742,820	6,127,452	5,924,513	202,939	21
93,961	511	523	324	217,135	2,175	690,281	2,444,051	2,398,653	45,398	22
62,039	246	290	315	224,351	1,172	473,981	1,879,872	1,543,256	336,616	23
15,069	95	95	92	59,060	428	116,945	496,499	438,976	57,523	24
93,371	482	507	440	309,416	2,389	890,410	2,970,597	2,526,024	444,573	25
5,421	32	32	61	34,136	122	66,656	304,979	276,387	28,592	26
36,153	220	222	117	70,851	756	311,662	1,107,303	953,201	154,102	27
1,165	11	11	14	648	23	9,228	35,006	21,557	13,449	28
9,949	87	87	41	22,333	238	114,785	396,639	384,685	11,954	29
48,980	246	249	410	277,707	1,864	932,623	2,738,695	2,707,121	31,574	30
2,481	12	12	12	8,627	39	16,593	54,445	36,484	17,961	31
246,015	713	735	2,318	2,065,567	7,765	3,766,101	16,352,193	15,810,195	541,998	32
16,252	125	130	81	43,752	400	105,190	346,472	299,118	47,354	33
6,762	49	49	22	12,371	147	59,117	235,371	184,857	50,514	34
222,767	757	867	809	488,757	5,469	1,963,779	6,192,640	5,477,077	715,563	35
10,385	52	76	50	32,420	231	68,196	268,222	189,339	78,883	36
21,172	118	120	127	27,829	618	294,229	659,146	627,665	31,481	37
186,572	772	890	1,475	1,000,978	6,682	2,847,340	8,083,896	8,054,253	29,643	38
10,467	82	93	56	31,554	265	71,766	285,055	249,759	35,296	39
10,305	103	108	54	25,656	217	81,046	287,057	227,468	59,589	40
36,060	158	162	342	216,730	1,399	469,942	1,252,438	1,162,466	89,972	41
64,410	334	348	311	229,546	2,032	816,396	2,485,925	1,970,357	515,568	42
5,734	22	22	65	43,358	157	81,120	293,952	279,130	14,822	43
12,112	103	104	62	29,475	237	98,296	322,369	293,531	28,838	44
24,130	139	146	142	73,182	522	150,702	609,276	540,503	68,773	45
31,447	140	140	171	37,499	1,160	608,956	989,936	935,556	54,380	46
22,376	180	185	94	49,820	623	202,998	507,677	443,263	64,414	47
61,145	342	344	314	171,138	1,465	518,353	1,599,833	1,325,497	274,336	48
12,489	34	36	101	67,465	470	234,499	865,603	792,222	73,381	49

[3] Includes District of Columbia.

[4] Includes systems distributed as follows: Rhode Island, 2; Wyoming, 2.

TABLE 44.—ALL TELEPHONE SYSTEMS—REVENUE AND

	STATE OR TERRITORY.	Number of systems.	REVENUE.						
			Total.	Gross receipts.	Dividends.	From lease of lines, wires, and conduits.	Rent from real estate.	Interest.	Miscellaneous.
1	United States	4,151	$86,825,536	$81,599,709	$268,044	$1,197,476	$1,348,894	$1,359,953	$1,051,400
2	Alabama [1]	47	528,821	477,936		765	4,098	39,289	6,733
3	Arizona [1]	11	114,480	113,645			333	439	63
4	Arkansas [1]	76	565,024	549,612			3,104	4,362	7,946
5	California	18	4,091,076	3,993,698			34,916	30,969	31,493
6	Colorado	13	1,137,263	1,103,089			20,175	12,659	1,340
7	Connecticut	6	1,328,186	1,172,543		134,359	7,717	4,141	9,426
8	Delaware [1]	3	189,846	187,164		148	1,806	265	463
9	Florida [1]	25	212,099	194,292			1,434	13,715	2,658
10	Georgia	78	863,033	764,764			8,191	76,599	13,479
11	Idaho [1]	7	178,282	168,573			2,708	800	6,201
12	Illinois	381	7,308,885	6,997,615		81,844	62,568	52,136	114,722
13	Indian Territory	37	164,142	163,315	540		287		
14	Indiana [1]	366	2,816,509	2,682,337	241	78,948	10,324	22,226	22,433
15	Iowa	411	1,962,362	1,898,949	1,995	1,663	2,688	27,272	29,795
16	Kansas [1]	172	877,783	860,996		24	3,548	2,304	10,911
17	Kentucky [1]	119	1,377,441	1,348,609	2,166	3,632	10,087	6,375	6,572
18	Louisiana [1]	15	803,399	784,455			6,002	6,234	6,708
19	Maine	27	597,204	575,034		40	162	8,759	13,209
20	Maryland [1]	20	1,517,102	1,406,944		28,965	51,734	20,675	8,784
21	Massachusetts	10	6,127,452	5,793,553		90,078	65,227	80,774	97,820
22	Michigan	110	2,444,051	2,318,165	1,376	3,913	46,454	28,258	45,885
23	Minnesota	151	1,879,872	1,787,793		3,009	15,305	17,801	55,964
24	Mississippi [1]	35	496,499	488,490			368	3,653	3,988
25	Missouri	317	2,970,597	2,840,884		18,209	35,850	20,545	55,109
26	Montana [1]	6	304,979	286,155		45	5,218	1,284	12,277
27	Nebraska	106	1,107,303	1,047,813		561	10,865	6,492	41,572
28	Nevada [1]	8	35,006	34,645			143	191	27
29	New Hampshire	16	396,639	383,842			108	5,812	6,877
30	New Jersey [1]	28	2,738,695	2,531,090		122,874	50,319	18,228	16,184
31	New Mexico [1]	12	54,445	54,376				20	49
32	New York	267	16,352,193	14,964,781	221,810	131,870	545,159	402,155	86,418
33	North Carolina [1]	83	346,472	330,618	3,204	126	1,024	9,817	1,683
34	North Dakota [1]	32	235,371	220,504		200	2,678	3,037	8,952
35	Ohio	285	6,192,640	5,824,002	21,656	148,342	85,508	62,245	50,887
36	Oklahoma [1]	24	268,222	265,615	100		628	409	1,470
37	Oregon [1]	21	659,146	637,617			7,179	4,335	10,015
38	Pennsylvania	97	8,083,896	7,235,212	11,027	284,332	163,658	242,581	147,086
39	South Carolina [1]	42	285,055	265,028			1,639	15,695	2,693
40	South Dakota [1]	54	287,057	279,720			1,339	1,450	4,548
41	Tennessee	43	1,252,438	1,228,111		43	7,419	8,026	8,839
42	Texas	169	2,485,925	2,398,970		180	16,908	24,691	45,176
43	Utah	5	293,952	272,507			5,964	1,450	14,031
44	Vermont	37	322,369	311,863		4	72	3,924	6,506
45	Virginia [1]	87	609,276	555,262		7,577	3,728	35,834	6,875
46	Washington [1]	4	989,936	967,301			8,308	7,576	6,751
47	West Virginia [1]	83	507,677	487,373		2,031	5,173	7,941	5,159
48	Wisconsin	183	1,599,833	1,555,091	3,929	13,040	9,238	13,304	5,231
49	All other states [4]	4	865,603	789,818		40,654	21,533	3,206	10,392

[1] Contains data for system credited to and operating in an adjoining state.

[3] Deficit.

AND EXPENSES, BY STATES AND TERRITORIES: 1902.

EXPENSES.														
Aggregate.	Operating expenses.							Fixed charges.				Dividends.	Net surplus.	
	Total.	General operation and maintenance, and legal expenses.	Rentals and royalties on instruments and apparatus.	Rentals of offices, etc.	Rentals of conduits, etc.	Telephone traffic.	Miscellaneous.	Interest. On floating debt.	Interest. On funded debt.	Taxes.	For lease of lines.			
$79,864,419	$56,591,746	$49,332,620	$2,832,361	$2,492,676	$681,727	$436,666	$815,696	$1,829,074	$3,511,768	$2,940,430	$9,752	$14,981,649	$6,657,792	1
448,020	314,312	273,013	19,538	17,347	....	1,922	2,492	63,569	5,960	20,096	....	44,083	80,176	2
75,064	68,508	62,071	2,020	4,022	....	267	128	435	2,960	2,948	....	213	38,038	3
439,872	368,340	310,076	37,238	13,168	....	1,589	6,269	18,404	1,372	11,448	300	40,008	125,152	4
3,924,471	3,196,595	2,938,045	164,021	87,543	....	1,542	5,444	11,576	136,225	82,803	480	496,792	162,947	5
1,032,325	766,071	698,395	37,462	30,033	....	....	181	3,682	3,416	27,587	....	231,569	104,855	6
1,305,284	886,839	813,671	48,405	21,291	974	10	2,488	13,840	44,154	25,226	....	335,225	22,378	7
208,508	157,375	144,331	5,013	6,135	164	....	1,732	25,355	14,617	7,924	1,001	2,236	[2]18,662	8
184,821	136,425	120,985	4,639	7,399	....	....	3,402	21,609	17,185	5,344	28	4,230	26,916	9
761,386	541,485	465,164	29,734	36,717	....	4,466	5,404	118,624	26,077	41,098	....	34,102	101,011	10
180,622	133,389	113,951	6,117	6,761	....	200	6,360	1,538	4,478	5,642	....	35,575	[2]3,340	11
6,801,492	4,962,193	4,390,964	252,195	200,912	7,876	31,206	79,040	85,730	175,639	264,038	444	1,313,448	454,288	12
103,888	93,533	81,334	4,305	4,397	....	2,104	1,393	2,689	1,200	2,355	....	4,111	60,254	13
2,375,588	1,759,050	1,553,180	56,694	53,883	....	64,399	30,894	61,241	202,587	101,915	3,286	247,509	402,164	14
1,494,821	1,207,554	1,057,581	43,419	48,228	....	15,578	42,748	54,820	54,119	28,443	150	149,735	408,283	15
625,548	520,861	462,328	20,218	18,691	....	2,109	17,515	17,509	8,740	19,693	....	58,745	249,847	16
1,225,821	909,524	827,349	49,654	25,697	572	4,705	1,547	21,419	121,576	35,961	12	137,329	148,564	17
718,466	414,845	359,317	40,817	14,078	....	612	21	16,218	21,554	27,809	....	238,040	84,855	18
568,510	408,758	359,010	25,335	13,036	....	2,896	8,481	3,904	20,815	14,252	140	120,641	28,383	19
1,443,624	1,105,541	969,843	64,276	57,398	11,368	1,116	1,540	44,464	130,791	59,326	29	103,473	73,023	20
5,924,513	4,206,394	3,677,559	228,006	236,321	2,087	....	62,421	32,279	204,345	366,879	146	1,114,470	202,939	21
2,388,188	1,709,781	1,475,733	64,541	81,251	....	33,584	54,672	123,004	307,265	58,195	245	189,698	45,140	22
1,536,685	1,129,707	976,307	52,685	43,188	331	3,266	53,930	56,595	76,275	49,621	65	224,422	335,965	23
438,851	302,827	273,593	19,243	9,328	....	592	71	10,484	12,081	11,608	175	101,676	57,523	24
2,496,278	1,757,472	1,527,239	105,317	75,053	3,308	9,395	37,160	58,255	155,221	112,849	528	411,953	438,732	25
275,412	212,847	174,555	11,485	11,337	....	1,557	13,913	1,591	964	10,055	....	49,955	28,592	26
945,605	791,770	699,098	42,050	21,266	369	443	28,544	3,036	6,353	28,976	....	115,470	152,965	27
20,337	17,242	15,449	1,221	494	....	....	78	31	1,269	644	....	1,151	13,409	28
384,685	305,071	274,439	14,424	11,091	....	367	4,750	2,684	13,760	6,710	60	56,400	11,954	29
2,707,121	1,937,262	1,753,699	93,609	86,704	90	142	3,018	92,974	94,576	81,951	60	500,298	31,574	30
36,484	32,206	28,828	1,408	1,733	....	122	115	254	229	800	....	2,995	17,961	31
15,801,697	9,781,125	7,903,625	578,860	578,606	649,239	25,051	45,744	161,626	331,503	651,692	....	4,875,751	541,460	32
297,727	241,219	219,539	7,209	7,043	....	1,944	5,484	18,562	7,374	7,546	400	22,626	47,290	33
184,717	136,470	115,984	6,447	4,722	....	44	9,273	7,139	1,726	4,730	305	34,347	50,514	34
5,461,908	3,785,548	3,240,393	154,257	138,606	1,983	162,204	88,105	171,530	590,765	252,243	420	661,402	715,130	35
189,209	169,833	156,869	3,689	6,239	....	1,262	1,774	5,984	1,373	4,369	....	7,650	78,883	36
625,037	449,193	404,241	30,083	14,485	....	138	246	3,010	3,445	11,588	....	157,801	31,446	37
8,047,994	5,387,852	4,824,742	187,925	255,768	2,009	8,501	108,907	204,598	450,100	266,243	....	1,739,201	28,980	38
248,967	186,206	170,495	5,857	8,558	....	219	1,077	27,068	12,338	6,712	....	16,643	35,296	39
226,380	162,174	148,027	4,483	4,630	....	365	4,669	3,652	2,180	5,583	5	52,786	59,589	40
1,153,811	873,897	795,657	58,035	16,639	45	2,807	714	28,078	49,371	28,500	....	173,965	89,683	41
1,968,878	1,583,327	1,372,293	88,997	64,929	....	32,321	24,787	86,046	78,400	54,765	307	166,033	515,522	42
279,130	215,541	173,924	13,048	12,668	....	....	15,901	1,760	1,197	10,405	....	50,227	14,822	43
292,875	233,439	206,389	12,276	7,312	....	1,716	5,746	2,927	9,193	5,921	350	41,045	28,821	44
532,380	396,156	345,866	16,006	22,000	383	4,635	7,266	54,465	16,978	25,813	320	38,648	68,451	45
935,556	778,837	709,125	41,363	26,956	....	....	1,393	2,691	35,267	19,038	....	99,723	54,380	46
439,852	337,115	300,647	10,095	16,060	29	3,718	6,566	13,771	29,562	12,776	98	46,530	64,414	47
1,313,845	977,316	879,844	43,462	38,968	....	7,552	7,490	67,345	22,945	38,802	398	207,039	273,844	48
792,166	542,721	487,853	25,180	23,985	900	....	4,803	1,009	2,248	21,508	....	224,680	73,381	49

[3] Includes District of Columbia.

[4] Includes systems distributed as follows: Rhode Island, 2; Wyoming, 1.

TABLE 50.—MUTUAL TELEPHONE SYSTEMS—SUMMARY, BY STATES AND TERRITORIES: 1902.

STATE OR TERRITORY.	Number of systems.	Miles of wire.	Subscribers.	Stations or telephones of all kinds.	EXCHANGES AND STATIONS.			PARTY LINES.		Switchboards of all kinds.	MESSAGES.			SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.	
					Public exchanges.	Automatic or nickel-in-the-slot pay stations.	Other pay stations.	Number.	Stations.		Total.	Local.	Long distance and toll.	Number.	Salaries.	Average number.	Wages.
United States..	994	70,915	88,520	89,316	942	18	384	9,258	77,581	942	99,141,483	98,433,170	708,313	166	$14,290	998	$163,670
Alabama	4	101	109	109	2	....	....	18	109	2	109,185	108,000	1,185	1	25	....	....
California	6	923	389	393	4	....	4	48	359	4	833,708	812,511	21,197	....	....	4	590
Colorado	3	70	28	28	....	....	....	3	28	....	21,020	20,700	320	....	....	....	....
Georgia	6	177	109	110	2	....	....	13	109	2	112,500	109,420	3,080	....	....	2	168
Illinois	138	13,308	16,717	16,831	163	....	41	1,536	14,078	163	24,946,971	24,885,109	61,862	33	1,427	180	32,627
Indiana	105	9,220	9,645	9,690	112	....	22	1,613	8,581	112	9,360,033	9,283,463	76,570	25	2,385	149	23,731
Iowa	170	13,261	21,197	21,355	168	5	23	1,754	18,255	168	20,276,319	20,120,311	156,008	9	1,135	184	37,504
Kansas	11	650	649	655	8	....	6	61	615	8	526,845	518,891	7,954	....	....	7	1,258
Kentucky	35	1,308	1,034	1,071	7	....	37	116	1,006	7	1,271,745	1,260,934	10,811	....	....	8	644
Maine	4	77	104	106	....	....	2	11	104	....	116,000	116,000	....	....	....	....	....
Maryland	4	81	43	52	5	....	9	18	43	5	58,200	57,500	700	....	....	....	....
Michigan	33	2,335	3,357	3,370	44	1	4	303	3,001	44	3,179,272	3,141,257	38,015	2	75	44	6,146
Minnesota	31	1,799	2,163	2,168	16	....	5	162	1,932	16	1,659,500	1,648,920	10,580	4	700	13	2,745
Mississippi	3	70	37	38	1	....	1	3	27	1	45,250	45,000	250	....	....	....	....
Missouri	90	8,564	10,858	10,962	120	....	47	1,173	9,209	120	12,464,695	12,383,649	81,046	25	2,807	135	20,905
Nebraska	32	1,656	1,633	1,644	23	1	6	201	1,502	23	2,076,923	2,052,758	24,165	3	160	23	3,935
New York	88	1,593	2,775	2,849	44	7	53	243	2,610	44	2,459,757	2,434,396	25,361	1	30	25	2,504
North Carolina	12	633	371	381	6	....	10	52	325	6	593,400	589,175	4,225	....	....	5	630
North Dakota	3	40	71	71	2	....	....	3	11	2	91,000	90,000	1,000	....	....	....	....
Ohio	49	3,516	6,019	6,036	71	....	13	703	5,803	71	6,363,650	6,315,949	47,701	17	481	71	9,693
Oregon	5	435	556	556	6	....	....	70	501	6	933,570	933,445	125	....	....	10	2,265
Pennsylvania	20	1,199	1,426	1,483	28	3	15	213	1,182	28	1,424,473	1,397,699	26,774	9	427	33	3,775
South Carolina	6	333	184	184	4	....	....	40	154	4	161,000	160,000	1,000	1	60	3	370
South Dakota	7	225	258	259	3	....	1	18	188	3	245,000	241,602	3,398	....	....	2	514
Tennessee	13	1,683	1,047	1,053	11	....	3	113	651	11	2,279,000	2,276,850	2,150	4	1,860	20	3,453
Texas	12	478	161	164	2	....	3	32	135	2	217,752	215,440	2,312	....	....	2	328
Vermont	6	106	171	173	1	....	2	30	172	1	163,950	163,800	150	....	....	....	....
Virginia	22	2,218	2,322	2,341	22	....	18	197	2,153	22	2,283,900	2,257,198	26,702	1	36	16	2,000
West Virginia	21	1,062	863	883	22	....	20	94	755	22	905,374	896,231	9,143	1	65	20	964
Wisconsin	43	3,263	3,897	3,963	40	....	31	388	3,763	40	3,560,756	3,498,787	61,969	24	1,775	32	4,253
All other states and territories[1]	12	531	327	338	5	1	8	29	220	5	400,735	398,175	2,560	6	842	10	2,668

[1] Includes systems distributed as follows: Arizona, 1; Connecticut, 1; Florida, 2; Idaho, 1; Louisiana, 1; Montana, 2; Nevada, 2; Oklahoma, 1; Wyoming, 1.

TABLE 51.—MUTUAL TELEPHONE SYSTEMS—REVENUE AND EXPENSES, BY STATES AND TERRITORIES: 1902.

STATE OR TERRITORY.	Number of systems.	REVENUE. Total.	REVENUE. From operation.	REVENUE. Assessments.	EXPENSES. Aggregate.	Operating expenses. Total.	Operating expenses. General operation and maintenance, including legal expenses.	Operating expenses. Rentals and royalties on instruments and apparatus.	Operating expenses. Rentals of offices, etc.	Operating expenses. Telephone traffic.	Operating expenses. Miscellaneous.	Fixed charges. Interest. On floating debt.	Fixed charges. Interest. On funded debt.	Fixed charges. Taxes.	Fixed charges. For lease of lines.	Dividends.	Net surplus.
United States	994	$303,325	$165,789	$137,536	$283,071	$275,316	$255,344	$4,652	$6,138	$5,594	$3,588	$2,303	$180	$3,851	$351	$1,070	$20,254
Alabama	4	625	150	475	620	597	597							23			5
California	6	3,658	2,301	1,357	3,519	2,979	2,124	178	170	443	64			4		536	139
Colorado	3	83	80	3	60	58	58							2			23
Georgia	6	636	612	24	431	400	362		24		14			31			205
Illinois	138	53,105	31,207	21,898	49,749	49,031	45,806	1,615	1,286	193	131	196	180	342			3,356
Indiana	105	38,757	19,889	18,868	35,985	35,056	33,490	16	497	820	233	279		410	240		2,772
Iowa	170	59,258	24,690	34,568	56,738	55,713	52,133	92	1,450	494	1,544	366		609	50		2,520
Kansas	11	2,388	1,437	951	2,231	2,062	1,978		72	12		46		123			157
Kentucky	35	3,056	1,460	1,596	2,854	2,793	2,746			42	5			61			202
Maine	4	311	127	184	311	282	277			5				5		24	
Maryland	4	455	455		431	395	395					30		6			24
Michigan	33	10,723	5,137	5,586	10,465	10,450	8,766	79	20	1,539	46			15			258
Minnesota	31	7,222	3,575	3,647	6,571	5,800	5,534		253		13	694		77			651
Mississippi	3	125	50	75	125	120	120					5					
Missouri	90	35,587	22,322	13,265	29,746	29,390	28,507		560	108	215	120		200	36		5,841
Nebraska	32	8,733	5,700	3,033	7,596	7,407	6,162	1,150	95			87		102			1,137
New York	88	9,036	6,229	2,807	8,498	7,526	6,701	433		353	39	62		375	25	510	538
North Carolina	12	1,455	1,260	195	1,391	1,383	1,383							8			64
North Dakota	3	140		140	140	130	125				5			10			
Ohio	49	15,602	5,665	9,937	15,169	14,914	13,208	36	1,155	500	15	87		168			433
Oregon	5	2,663	2,362	301	2,628	2,628	2,515	60	48		5						35
Pennsylvania	20	6,922	4,421	2,501	6,259	6,034	5,731	115	120	42	26	95		130			663
South Carolina	6	792	480	312	792	773	773							19			
South Dakota	7	1,088	912	176	1,088	1,048	1,038		10					40			
Tennessee	13	8,944	8,448	496	8,655	8,511	8,282		144	75	10	64		80			289
Texas	12	1,525	1,234	291	1,479	1,432	628	248		550	6			47			46
Vermont	6	673	348	325	656	629	629							27			17
Virginia	22	8,445	3,528	4,917	8,123	7,506	7,247		44	100	115	74		543			322
West Virginia	21	3,411	3,156	255	3,411	3,205	2,984	115	15	58	33	33		173			
Wisconsin	43	12,144	5,549	6,595	11,652	11,461	10,237	50	100	5	1,069	65		126			492
All other states and territories[1]	12	5,763	3,005	2,758	5,698	5,603	4,808	465	75	255				95			65

[1] Includes systems distributed as follows: Arizona, 1; Connecticut, 1; Florida, 2; Idaho, 1; Louisiana, 1; Montana, 2; Nevada, 2; Oklahoma, 1; Wyoming, 1.

PART II

TELEGRAPHS

PART II.

TELEGRAPHS.

CHAPTER I.

TELEGRAPH AND CABLE SYSTEMS.

General statistics.—Prior to 1902 the only census at which statistics for telegraphs was reported was that of 1880, which covered the fiscal year ending nearest to June 1, 1880. But as the reports of that census contain no data relative to domestic ocean cable systems, the statistics are not strictly comparable with those for 1902. The comparison of the totals for the two censuses can be used, therefore, only as a general indication of the magnitude of the industry at the two periods.

The statistics concerning the telegraph and ocean cable systems relate to all operations of commercial land telegraph companies owned and operated within the United States, and of domestic ocean cable companies operating from the United States. The close relationship between the land and ocean telegraphs makes it impossible to present the statistics for the two classes separately.

As the majority of the telegraph systems are operated in a number of states, their business could not be segregated so as to show the capitalization, income, expenses, and equipment for the different states. Hence only the totals for the United States are given.

It should also be noted that in compiling the statistics for telegraphs the systems were divided into two general classes—the commercial land telegraph and the ocean cable systems, including all systems organized primarily for the transmission of messages for the general public; and the railway telegraphs, including all wires owned and operated in connection with a railway system, to subserve its business of a common carrier, or operated by a commercial telegraph company, through an arrangement with the railway company along the right of way on which the wires are strung, whereby messages relating to the railway business are given preference. The railway telegraph statistics are treated later in a separate table. The commercial telegraph systems are given in Table 1.

TABLE 1.—*Commercial systems—comparative summary: 1902 and 1880.*

	1902	1880
Number of systems	25	[1] 77
Miles of wire	[2] 1,318,350	291,213
Messages:		
Number	[3] 91,655,287	[4] 31,703,181
Receipts	[5] $29,118,089	[4] $13,512,116
Telegraph offices, number	27,377	12,510
Salaried officials, clerks, etc., number	829	337
Wage-earners, total number	26,798	14,591
Operators	13,093	9,661
Messengers	4,746	2,469
All others	8,959	2,461
Salaries and wages	$15,039,673	$4,886,128
Capital stock: [6]		
Authorized, par value	$123,233,075	$75,907,250
Outstanding, par value	$117,053,525	[7] $66,529,200
Total revenue	$40,930,038	$16,696,623
Gross receipts from telegraph traffic	$35,300,569	$13,512,116
From other sources	$5,629,469	$3,184,507
Total expenses	$37,204,727	$14,959,372
Salaries and wages	$15,039,673	$4,886,128
Operation and maintenance	$9,220,948	$3,846,039
Interest	$1,950,282	$564,341
Dividends	$6,256,693	$4,136,750
All other expenses	$4,737,131	[8] $1,526,114
Net surplus	$3,725,311	$1,737,251
Balance sheet: [6]		
Total assets	$195,503,775	$97,232,640
Construction and equipment	$156,911,448	$93,062,922
Real estate, stocks and bonds, machinery, etc.	$32,220,204	([9])
Bills and accounts receivable	$3,084,739	$3,081,922
Cash and deposits	$3,287,384	$1,087,796
Total liabilities	$195,503,775	$97,232,640
Capital stock	$117,053,525	$67,901,255
Bonds	$45,893,000	[10] $9,369,165
Cash investment of unincorporated companies, reserves, bills and accounts payable, dividends unpaid, and surplus	$32,557,250	[11] $19,962,220

[1] Includes 6 operated by Western Union Telegraph Company.
[2] Includes miles of wire operated by the Western Union Telegraph Company outside the United States, but does not include 16,677 nautical miles of cable operated by submarine cable systems.
[3] Includes 820,498 cable messages.
[4] Both number of messages and receipts were reported for 54 companies, while 17 others reported receipts only.
[5] Includes $1,326,967, receipts for cable messages.
[6] Reported by only 42 companies in 1880.
[7] For cash.
[8] Includes $40,000, sinking fund appropriation.
[9] Not reported separately in 1880.
[10] Includes funded and floating debt.
[11] Reported as profit and loss.

It will be seen from Table 1 that the telegraph systems of the country owned and operated 1,318,350 miles of wire, to which should be added 16,677 nautical miles of submarine cable. They had 27,627 employees; an investment, or capitalization of stocks and bonds, of $162,946,525; a total revenue of $40,930,038; and total assets of $195,503,775. They paid $6,256,693 in dividends and $1,950,282 in interest on bonds. In all these respects, as well as in the number of messages, the telegraph was surpassed by its younger rival, the telephone, and, while the telegraph has intrinsically grown rapidly and has in itself the elements of steady increase, the statistics in this report give every warrant for the belief that each year must see a wider disparity between these two vital means of intercommunication.

Chief features of the data.—The striking decrease between 1880 and 1902 in the number of separate holdings, due to the numerous consolidations which have taken place of corporations previously competing or not before under one ownership, has been accompanied by a very great increase in the magnitude of equipment and business. In 1902 the telegraph business was practically controlled by two companies, yet, in spite of the tendency of consolidation to reduce the number of lines and offices, the mileage of wire in operation was more than four times and the number of messages nearly three times greater than in 1880.

The wire mileage in operation in 1902, exclusive of 16,677 nautical miles of cable, was 1,027,137 miles greater than in 1880.

The comparison of the number of messages sent during the two census years is affected by the fact that, in addition to the 820,498 cable messages included in the total for 1902, an unknown number of cable messages was reported by a company that did both a land and ocean business, and whose report could not be segregated. Moreover, in 1880, the number of messages was reported for only 54 companies; of the 23 other companies, 17 reported only "receipts from messages," 5 kept no records, and 1 had no message business.

The average rate per message in 1902, after deducting the number of cable messages and receipts therefrom, was 31 cents, as compared with 43 cents in 1880.

The number of telegraph offices in 1902 was 27,377, an increase of 14,867, or 118.8 per cent over 1880. Of the total number in 1902, 20,809 were in railway stations.

Between 1880 and 1902 the number of salaried officials, clerks, etc., increased from 337 to 829, or 146 per cent; the total number of wage-earners, from 14,591 to 26,798, or 83.7 per cent; the number of telegraph operators, from 9,661 to 13,093, or 35.5 per cent; and the amount paid in salaries and wages, from $4,886,128 to $15,039,673, or 207.8 per cent.

Comparison with the telephone.—It is an interesting and not altogether unprofitable speculation to attempt a determination of the effect of the telephone in reducing or checking the amount of telegraph business. This effect is produced in two ways—by substituting the long distance telephone call for the telegraph message between two widely separated points, and by obviating to a very large extent the necessity for using the telegraph within city limits. The effect of the telephone on the district messenger service is referred to later. As to long distance and toll line telephone talks or messages, the figures of telephone traffic give these as no fewer than 120,704,844, or nearly thirty millions more than the total number of telegraph messages. While a great deal of the telephone traffic has been new and self-originated, its competition has kept down the use of the telegraph. The rates of the two systems for medium distances do not differ greatly, and for very long distances they are overwhelmingly in favor of the telegraph, if the message be taken as the unit; but if the number of words exchanged be taken into account, as well as the time required for getting into communication, the telegraph is at a disadvantage in case of a large amount of traffic. Frequently the brief message will suffice, and the written telegraph serves as a record, but where a swift interchange is required, the telephone seems to have thoroughly established its superiority for social matters and for business. The public employs the telegraph at the rate of only a little more than once a year per capita, whereas the number of telephone messages is already 65 per capita.

Comparative data—earnings and expenses.—In the reports of the census of 1880 statistics of revenue and expenses were presented for 75 of the 77 systems or companies. The 2 other companies (one was not in regular operation, while the other did not have the necessary records) reported a combined mileage of only 301 miles. The 1880 statistics of assets and liabilities covered the operations of 42 companies. Of the 35 other companies—many of them of a petty character—18 were lines owned by railway companies which included the data for both railway and telegraph business in the same balance sheet, 7 failed to give a reason for not furnishing the data, 4 made reports that were too incomplete and unreliable to be included in the table, and 3 were private concerns. Of the 25 telegraph systems reported in 1902, 21 were operated by incorporated companies. The capitalization of these companies is shown in Table 2.

TABLE 2.—*Capitalization of incorporated companies: 1902.*

Number of incorporated companies	21
Capital stock and bonds authorized, par value	$173,126,075
Capital stock and bonds outstanding, par value	$162,946,525
Capital stock:	
Total authorized, par value	$123,233,075
Total outstanding, par value	$117,053,525
Dividends paid	$6,256,693
Common—	
Authorized, par value	$122,033,075
Outstanding, par value	$115,853,525
Dividends paid	$6,193,693
Preferred—	
Authorized, par value	$1,200,000
Outstanding, par value	$1,200,000
Dividends paid	$63,000
Bonds:	
Authorized, par value	$49,893,000
Outstanding, par value	$45,893,000
Interest paid	$1,949,150

Of the total authorized capitalization of commercial telegraph systems, capital stock constituted 71.2 per cent and bonds and funded debt 28.8 per cent. Of the total authorized capital stock, $117,053,525, or 95 per cent, had been issued and was outstanding at the end of the year covered by this report. Of this amount, 99 per cent was common, and 1 per cent preferred stock.

The dividends paid on the capital stock outstanding amounted to $6,256,693, the average rate being 5.3 per cent. Dividends amounting to $6,193,693 were paid by 10 companies on common stock, having a par value of $113,913,725, so that the average rate was 5.4 per cent. Only 1 company was authorized to issue preferred stock, and the entire amount, $1,200,000, was outstanding. This company paid on its preferred stock dividends amounting to $63,000, the rate being 5.3 per cent. Ten companies, having capital stock to the amount of $1,939,800, paid no dividends during the year covered by this report.

Bonds were outstanding to the amount of $45,893,000, and $1,949,150 was reported as paid in interest, the average rate being 4.2 per cent.

The total revenue and expenses of the 25 companies for the year covered by their reports are arranged in Table 3 in the form of an income account.

TABLE 3.—*Commercial systems—income account: 1902.*

Gross receipts from operation		$35,300,569
Operating expenses		26,592,411
Net earnings from operation		8,708,158
Income from other sources:		
Dividends on stock of other companies	$1,150,658	
Lease of lines, wires, and conduits	4,185,799	
Rent from real estate	205,070	
Interest	6,719	
Miscellaneous	72,223	
		5,629,469
Gross income less operating expenses		14,337,627
Deductions from income:		
Taxes	588,726	
Interest—		
Floating debt	1,132	
Funded debt	1,949,150	
Paid for leased lines	1,816,615	
		4,355,623
Net income		9,982,004
Deductions from net income:		
Dividends on preferred stock	63,000	
Dividends on common stock	6,193,693	
		6,256,693
Net surplus for year		3,725,311

The total receipts of the commercial telegraph companies amounted to $40,930,038. Of this total, $35,300,569, or 86.2 per cent, represents the gross receipts from operation, including all receipts for messages sent over the lines of the telegraph systems in this country, whether originating in this country or forwarded for other systems under traffic agreement. The "income from other sources" amounted to $5,629,469, or 13.8 per cent of the gross revenue.

The operating expenses are presented in Table 4.

TABLE 4.—*Commercial systems—operating expenses: 1902.*

Total	$26,592,411
General operation and maintenance	24,260,621
Salaries of corporation officers	230,250
Salaries of general officers	255,740
Salaries of clerks	676,642
Wages	13,877,041
Operation and maintenance	9,220,948
Legal expenses	194,890
Rentals of offices and other real estate	875,213
Rentals of conduits and underground privileges	7,808
Telegraph traffic paid or due other companies	724,826
Miscellaneous	529,053

It is probable that the $26,592,411 shown for operating expenses includes all expenses that can be charged to the operation of the 1,318,350 miles of single wire and the 16,677 nautical miles of ocean cable.

Of all operating expenses, salaries and wages together amounted to $15,039,673, or 56.5 per cent; the other principal item, operation and maintenance, amounted to $9,220,948, or 34.7 per cent; and the remaining items of expense—legal expenses, rentals, telegraph traffic paid or due other companies, etc.—amounted to $2,331,790, or 8.8 per cent.

Fixed charges, which consist of taxes, interest, and payments for leased lines, amounted to $4,355,623. Deducting this from $14,337,627, shown as gross income less operating expenses, there remains a net income of $9,982,004. Deducting from the net income the $6,256,693 paid in dividends on the preferred and common stock, there remains a net surplus of $3,725,311.

In addition to the cost of repairs and renewals, included in the item operation and maintenance, an expenditure of $4,776,763 for new construction was reported by 7 of the 25 telegraph systems.

While different methods of bookkeeping were used by the several systems, and different items shown in their annual statements of assets and liabilities, it was found possible in every case to secure the amounts required to construct a balance sheet of the character shown in Table 5.

TABLE 5.—*Commercial systems—balance sheet: 1902.*

Total assets	$195,503,775
Construction and equipment	156,911,448
Real estate	4,768,131
Stocks and bonds of other companies	25,939,944
Machinery, tools, and supplies	945,795
Bills and accounts receivable	3,084,739
Cash and deposits	3,287,384
Sundry	566,334
Total liabilities	195,503,775
Capital stock	117,053,525
Bonds	45,893,000
Cash investment, unincorporated companies	7,310
Reserves	7,859,648
Bills and accounts payable	6,244,585
Dividends unpaid	366,666
Surplus	18,079,041

The amounts shown in Table 5 are the sum of those shown in the balance sheets of the 25 systems for the business year most nearly conforming to the calendar year 1902. The cost of construction and equipment of the various systems amounted to $156,911,448, or 80.3 per cent of the total assets. Stocks and bonds of other companies, held for investment or to control the operation of such companies, were valued at $25,939,944, and the real estate owned was valued at $4,768,131. These two items constituted 13.3 per cent and 2.4 per cent, respectively, of the total assets.

Of the liabilities, $117,053,525, or 59.9 per cent, represented capital stock outstanding, and $45,893,000, or 23.4 per cent, outstanding bonds. The cash investment of unincorporated systems amounted to $7,310, or less than one-tenth of 1 per cent; reserves and surplus combined, $25,938,689, or 13.3 per cent; bills and accounts payable, $6,244,585, or 3.2 per cent; and dividends unpaid, $366,666, or two-tenths of 1 per cent.

Salaries and wages.—As in the case of telephony, so for telegraphy, the number of salaried officials, clerks, etc., the average number of wage-earners employed during the year, and the amount paid in salaries and wages were asked. Table 6 shows the total for all systems.

TABLE 6.—*Commercial systems—employees, salaries, and wages: 1902.*

Salaried officials, clerks, etc.:	
Total number	829
Total salaries	$1,162,632
Corporation officers—	
Number	54
Salaries	$230,250
General officers—	
Number	82
Salaries	$255,740
All other employees in general offices—	
Number	693
Salaries	$676,642
Wage-earners:	
Total average number	26,798
Total wages	$13,877,041
Managers and assistants—	
Average number	5,752
Wages	$2,898,588
Operators—	
Average number	13,093
Wages	$8,862,349
Male—	
Average number	10,179
Wages	$7,494,909
Female—	
Average number	2,914
Wages	$1,367,440
Inspectors—	
Average number	1,152
Wages	$573,369
Linemen—	
Average number	1,208
Wages	$573,088
Messengers—	
Average number	4,746
Wages	$839,360
All other wage-earners—	
Average number	847
Wages	$130,287

Of the total amount paid to salaried officials, clerks, etc., $230,250, or 19.8 per cent, was paid to corporation officers; $255,740, or 22 per cent, to general officers; and $676,642, or 58.2 per cent, to all other employees in general offices.

In addition there were employed, on an average, during the year 26,798 wage-earners, to whom $13,877,041 was paid in wages. Of this amount, managers and assistants received $2,898,588, or 20.9 per cent; male operators, $7,494,909, or 54 per cent; female operators, $1,367,440, or 9.9 per cent; inspectors, $573,369, or 4.1 per cent; linemen, $573,088, or 4.1 per cent; and messengers, $839,360, or 6.1 per cent. The amount paid messengers does not represent the total cost of messenger service, inasmuch as the delivery of messages is intrusted to a great extent to local district messenger companies with which the telegraph systems have contracts. A sharp contrast is to be noted in the numbers of women operators employed in telegraphy and telephony, the former industry having 10,179 and the latter 37,333.

Wire mileage.—Of the 1,318,350 miles of wire shown in Table 1 as operated by commercial telegraph companies, 1,307,046 miles were owned or leased by such companies. The remainder was owned by railway companies. The details of line construction are shown in Table 7.

TABLE 7.—*Commercial systems—line construction: 1902.*

Total miles of wire owned or leased	1,307,046
Underground:	
Miles of duct [1]	190
Owned	96
Leased	94
Miles of cable	399
Owned	367
Leased	32
Miles of single wire	21,658
Owned	17,265
Leased	4,393
Submarine: [2]	
Miles of cable	106
Circuit miles of wire in cable	679
Overhead:	
Miles of pole line	237,990
Owned	218,148
Leased	19,842
Miles of single wire	1,265,668
Copper wire owned	333,456
Iron wire owned	863,953
Wire leased	68,259
Circuit miles of wire in cable	19,041
Miles of cable	1,467

[1] Western Union Telegraph Company failed to report number of miles of duct in which their underground cables were laid.
[2] Does not include ocean cables of submarine cable companies.

Of the 1,307,046 miles of wire reported as "owned or leased," 1,234,394 miles, or 94.4 per cent, were owned, and 72,652 miles, or 5.6 per cent, were leased by the companies reporting. Of the owned wire, 1,216,450 miles, or 98.5 per cent, was overhead; 17,265 miles, or 1.4 per cent, was underground; and 679 miles, or one-tenth of 1 per cent, was in submarine cable.

Telegraph power plants.—Table 8 shows the number and horsepower of the various units of the electric power generating plants of the commercial telegraph companies.

TABLE 8.—*Commercial systems—generating plants in offices: 1902.*

Engines:	
Number	20
Horsepower	340
Dynamos:	
Number	75
Horsepower	321
Motor generators:	
Number	1,138
Horsepower	1,616
Batteries in offices:	
Primary, number of cells	634,626
Storage, number of cells	19,733

In the earlier days every telegraph office depended upon primary batteries for its supply of current, but now all the larger offices and many of the less important ones have power plants of their own or have motor-generator sets for furnishing the different types of current required.

Methods of telegraphic operation.—There are four different methods of operating telegraph wires: The single or Morse system, by which only one message can be sent by key at a time; the duplex system, by which two messages can be sent simultaneously in opposite directions over the same wire; the quadruplex system, by which four messages can be transmitted over one wire at the same time—two from each end simultaneously; and printing and automatic systems, which make possible a higher rate of speed than can be attained by hand. The message in automatic machine systems, as in the familiar Wheatstone, is usually prepared beforehand by perforating strips of paper that are then run through the transmitter at a high rate of speed. By one of the later printing systems the Western Union Telegraph Company has transmitted over 1,500,000 messages, but at the same time they do not gain ground either here or in Europe. The distribution of the 1,307,046 miles of wire owned or leased, according to the method of operation, is shown in Table 9.

TABLE 9.—*Commercial systems—miles of wire owned or leased, distributed according to method of operation: 1902.*

METHOD OF OPERATION.	MILES OF WIRE.	
	Number.	Per cent.
Total	1,307,046	100.0
Single	816,593	62.5
Duplex	185,048	14.1
Quadruplex	294,910	22.6
Machine or automatic	10,495	0.8

In addition to the 679 circuit miles of wire in submarine cable, shown in Table 7, as owned and operated within the limits of the United States, a total length of 16,677 nautical miles was reported for 20 ocean cables reaching the shores of the American continent for intercourse with the United States.

Press messages.—Due credit is not given in the statistics of business, and could not well be given, for the telegraphic traffic of the news purveying and distributing systems, upon which the public depends to a very large extent for its news of the day. The thousands of daily newspapers in the United States receive telegrams of a news character, some of which are exclusive, but the great majority of which are identical throughout the country, and, even if edited in accordance with the relative importance to the local reader, are exactly of the same nature and length when sent out in multiple from headquarters in such cities as New York or Chicago. This enormous news telegraphic traffic shows in the income of the telegraph system but is incalculable otherwise as to number of words, number of messages, etc. Not only are details of the great markets thus furnished daily, but all great events and minor occurrences, such as elections, races, fires, conventions, and speeches, are, under a special schedule, the subject of endless duplication and manifolding in the telegraphic traffic of the daily press. The same press tariff is also granted to other than the daily journals. Some idea of what such work may amount to in the aggregate is afforded by the statistics of telegraph traffic in England, where the system is in the hands of the Government and is subjected to close accounting. The Postmaster-General reported that, during the year 1903–4, the average number of words per week in press telegrams reached the gigantic total of 14,588,458. This is known to be far below the American figures, where, moreover, the telegraph is supplemented in many parts of the country by the large use of the telephone for news messages.

District messenger system.—The general statistics of the district messenger business are not included in the present report, for the reason that the industry has not been considered as strictly within the scope of this investigation. Practically no telegraph or telephone business originates with the district messenger companies, which have two main functions. One of these is to handle the telegraph messages of telegraph companies, like the Western Union Telegraph Company and Postal Telegraph Cable Company, which control, own, and officer these subordinate organizations; and the other function is to carry urgent written messages and distribute parcels and packages. It will be seen that the latter of these two functions is in no sense electrical or telegraphic, although for the collection of telegraph messages to be placed on the wires, district messenger "call" boxes, connected by wire with the messenger headquarters, are installed in a large number of business offices, residences, etc. A third function of the district messenger companies, which is understood to be the most profitable branch of the business, but is, in the sense of this report, not telegraphic, is that of conducting a burglar alarm service, special boxes and circuits being equipped for such purpose.

Of late years the development of the telephone and other distributing agencies has diminished the usefulness of the district messenger system as hitherto employed in urban centers, as a probable result of which the American District Telegraph Company of New Jersey was incorporated in November, 1901, as a holding company. This company has acquired the control of about fifty district messenger companies, operating, it is said, in about one thousand of the more important cities and towns in the United States, exclusive of New York city. This company, which has a twenty-five-year contract with the Western Union Telegraph Company for the delivery and collection of messages, has an authorized capital stock of $10,000,000, of which $9,500,000 is outstanding. On this a dividend of 5 per cent was paid up to 1904, when the rate was reduced to 4 per cent. All message collection and delivery business of the Western Union Telegraph Company in New York city is handled by the local American District Messenger Company, which operates 85 offices in New York city, with 1,552 miles of circuit, 29,143 instruments, and 1,200 messengers. The authorized capital stock of this company is $4,000,000, of which $3,844,700 is outstanding. The dividends upon this in 1902 and 1903 were 2 per cent. The revenue from all sources was $567,676 and the operating expenses, inclusive of construction, $511,808. The net income was $65,868 and the dividends $76,888, leaving a deficit of $11,020. These figures are compiled from the last annual report of the company. It may be added that the Postal Telegraph Cable Company has organized a number of district messenger companies to render services analogous to the above, but in regard to these also no figures were collected.

The stock quotation service.—A part of the telegraph force of the country, more particularly in the large cities, is employed in handling stock quotations, a large number of the operators being in private employ. The quotations are not brought to separate account as messages, except perhaps in the figures of work done by the submarine cables; but it has been stated on good authority that there are on an average 1,000 Wall street cable messages per day, or about three hundred thousand per year; but this would by no means include all the cablegrams relative to prices of, or speculation in, stocks, wheat, pork, cotton, coffee, tobacco, etc.

The extent of the use of telegraphy in transmitting stock quotations is not perhaps fully appreciated, although the public is quite familiar with the stock ticker and the paper tape upon which the ticker prints its abbreviated record of sales and prices. The largest amount of this work is done in New York city, and under the direct supervision of the stock exchange, which treats the quotations made within its walls as the property of the exchange and its members. One stock quotation system, with about one thousand tickers in service, is owned and operated by the exchange. This system sent out over the tape nearly thirteen million separate impressions in 1901–2, and over seventy-five thousand on some days, while it required about fifty tons of paper to keep the tickers supplied with reels of narrow tape. In addition to this official service, there is another under exchange supervision, which furnishes tickers to about seven hundred and fifty customers in and around New York. Besides these nearly one thousand more tickers are employed on Manhattan Island in reporting produce, general news, sporting intelligence, etc. It will be seen that in the aggregate a vast amount of telegraphic service is thus furnished to the public. But this is not all, as outside of New York city twenty large cities have ticker services of their own, which in Chicago, Philadelphia, Boston, etc., represent a further patronage of this special form of telegraphy, now an indispensable part of daily life to the financial and commercial world. The ticker service is also supplemented by a news system, which consists of bulletins sent out by one or two enterprising agencies and depends in large measure upon telegraphic advices for its material. It is extremely difficult to bring such work to specific account, but an estimate was made a few years ago by one of the presidents of the Western Union Telegraph Company that 46 per cent of the messages transmitted were in reference to speculation of some kind.

Commercial telegraphs on steam railroads.—Along the right of way of steam railway companies the commercial telegraph systems had 181,921 miles of pole line, on which were strung 954,319 miles of single wire, or 72.4 per cent of the total wire mileage operated by all commercial telegraph systems, as shown in Table 1. Of this wire, 935,409 miles were copper and 18,910 were iron. In addition to this wire the railway companies owned and operated a large mileage in connection with the transportation business.

Railway telegraphs and telephones.—There were 684 railway companies that reported the operation of telegraph or telephone lines in connection with the transportation business. In their reports to the Interstate Commerce Commission the railway companies furnished considerable information concerning their telegraph and telephone systems. This information was supplemented by data obtained by the Bureau of the Census through correspondence with the companies. The results of the combined inquiries are summarized in Table 10.

TABLE 10.—*Railway telegraphs and telephones—summary: 1902.*

Number of companies reporting	684
Number of telegraph offices	31,278
Telegraph operators and dispatchers:	
Number	30,336
Wages	$20,040,730
Number of sets of instruments:	
Morse	85,150
Other	603
Number of cells of battery:	
Primary	278,293
Storage	11,914
Miles of single track	204,503
Total miles of wire	1,127,186
Owned	242,837
Not owned	884,349
Number of telephones in use	17,606
Number of telegraph messages sent during year:	
For railroad business only	201,743,756
Commercial	4,474,593

The railway companies for which data are included in Table 10 operated 204,503 miles of single track and had 1,127,186 miles of single wire along their right of way. Of this wire mileage, which includes both telegraph and telephone lines, no segregation being possible, only 242,837 miles, or 21.5 per cent, were owned by the railway companies.

A large proportion of the telegraph and telephone wire along the right of way of railway companies, and a considerable proportion of that operated by the railway companies is owned by commercial telegraph or telephone companies and is included in their reports. Hence an unknown portion of the wire mileage reported for railway telegraphs and telephones is a duplication of that shown in the report on commercial telegraph companies. Moreover, many of the commercial messages reported are included, also, among the messages reported by the commercial telegraph companies. Few railway companies, however, maintain telegraph lines for other than railway business, the commercial privileges, as a rule, being granted to commercial telegraph companies.

The railway companies reported 31,278 telegraph offices, but only 30,336 telegraph operators. It is probable that in a number of instances the railway companies reported as station masters, agents, etc., employees who also performed the duty of telegraph operator, and that these were not included with the operators.

CHAPTER II.

GOVERNMENTAL TELEGRAPH AND TELEPHONE SERVICE.[1]

Several branches of departments of the United States Government depend largely in their work upon the employment of the telegraph and telephone. Chief among these are the Signal Corps, the Weather Bureau, and the Life-Saving Service.

United States Signal Corps.—One of the earliest demonstrations of the value of telegraphy in warfare was that given in the United States during the Civil War, when for several years a large body of operators on both sides was employed in the maintenance of communication between the forces scattered over the immense area embraced in the field of conflict. On the Federal side no fewer than 1,200 operators were thus employed in the field, sharing all the perils and vicissitudes of the war. Out of the conditions thus developed sprang the present telegraphic system operated by the Signal Corps of the United States Army under the Chief Signal Officer. According to the report made for 1903–4 by Gen. A. W. Greely, Chief Signal Officer, this corps has by law an authorized strength of 1 brigadier-general, 1 colonel, 2 lieutenant-colonels, 6 majors, 18 captains, 18 first lieutenants, 36 master signal electricians, 132 first-class sergeants, 144 sergeants, 156 corporals, 552 first-class privates, 168 privates, and 24 cooks—a total of 46 officers and 1,212 enlisted men. At headquarters in Washington a staff consisting of 1 chief clerk, 1 chief of disbursing division, 26 clerks, 3 messengers, and 1 laborer is also necessary for the prompt and satisfactory transaction of public business passing through the office. At the Signal Corps post at Fort Myer, Va., the Corps has an important school of instruction, although work of a more extensive character is now being done at Omaha, Nebr., in the instruction of enlisted men in signaling, telegraphing, telephoning, ballooning, etc. During the year military telegraph lines, with an aggregate length of 507.5 miles, were in operation at ten different posts, and handled 41,805 messages, while at four different posts, lines aggregating 254 miles were transferred or abandoned. The sum of $2,213.07 was collected for the transmission of commercial telegrams over the military lines, and the sum of $3,450.65 was collected and transferred to commercial companies, the latter amount covering tariffs for messages transmitted by such companies over their land lines.

The Signal Corps in the Philippines.—These statistics, however, are far from doing justice to the work of the Signal Corps, particularly in Alaska and in the new American possessions in the Philippines. At the end of the fiscal year 1903–4 no less than 42 per cent of the enlisted force of the Signal Corps was still serving in the islands, and fully 50 per cent of the entire Corps has been required by military necessities to serve there for periods ranging from two to four years. The work of the United States Signal Corps in the Philippine archipelago marks in reality a distinct advance in the application of electricity to the art of war. In extent of mileage of circuit, rapidity of development, and number of military messages transmitted its operations have surpassed those of any previous military system of communication. The submarine cables laid and land lines built had an aggregate length of 10,450 miles, of which 7,000 miles were operated at one time. General Greely states that the official messages have run into the millions, and that in Manila alone over 100,000 words were handled by the Corps in a single day. For the first four and one-half years the entire expenditure for material and instruments, submarine cables, and other expenses out of the Signal Corps appropriation aggregated $1,381,614. In connection with this work the disbursements of other bureaus of the Army, etc., have been estimated at $1,100,000, making the total cost, direct and indirect, for the entire plant and its operation and maintenance almost $2,500,000. During the year of active operations the cost of sending words over land lines was about five mills per word, and over submarine cables three cents per word. This includes the cost of plant, operation, maintenance, and all other expenses, but does not take into account the value of lines and material on hand or transferred to the civil government. In this connection it is interesting to note that the estimated cost of telegrams over the British military telegraph system in South Africa was fixed at about seven mills per word. The average for the Philippines covered, however, only the operation of land lines, whose original installation is less costly than submarine cable, while in the South African figures credit is taken for the full value of all stores and other material used in the construction of the lines transferred to the civil administration after the Boer War.

[1] Many of the statements in this chapter are derived from the Annual Report of the Chief Signal Officer, U. S. A., for the year ending June 30, 1904, and from the Report of the Chief of the Weather Bureau for 1902–3.

Up to June 30, 1904, there had been transferred by the Signal Corps to the civil government of the Philippines 2,965 miles of land lines and submarine cables. Yet, as a matter of fact, the United States Army in 1898 had found the islands practically destitute of telegraphic facilities, the insurgents having destroyed the few Visayan lines of the Eastern Extension, Australasia, and China Telegraph Company (Limited). By the fortune of war there came into the possession of the Signal Corps about 400 miles of dilapidated and antiquated line in northern Luzon, but the system as it stands at the time of this report is virtually a new creation throughout.

The tariff value of the messages sent by the Signal Corps under disturbed conditions in the Philippines can not be satisfactorily determined, according to General Greely. It may be stated, however, that the Eastern Extension Telegraph Company (the only commercial system operating in the islands) at a minimum commercial tariff of 5 cents a word for official business would have received for this work $7,758,750. As will be noted, the cost to the United States, through the operations of the Signal Corps, was less than one-third of this amount. There should be added also in these estimates the charges for more than 2,000,000 telephone messages, amounting, at 10 cents per message, to at least $200,000. There should also be credited to the Signal Corps the tariffs, amounting to $82,996.12, collected for commercial messages and dispatches and paid into the insular treasury. Gratifying as this exhibition is, the service rendered has obviously been too valuable to be measured by tariff rates. On this point Gen. Arthur MacArthur may be quoted as follows:

> The wire service of the Signal Corps is simply indispensable. It is not too much to say that in the absence of this efficient service it would be impossible to hold this archipelago with less than 150,000 men, which is now well and efficiently performed by 60,000. We need wires, instruments, and operators everywhere—the more the better. It simplifies everything, makes unity of action possible, insures concentration of troops on threatened points, and, altogether, is of such importance that it is impossible to say too much in behalf of its indefinite extension to the limit of possible usefulness. . . . The purpose of the present writing is to impress the War Department with the view that successful operations in these islands absolutely depend upon the Signal Corps, in consequence of which provisions therefor should be made upon a scale commensurate with the importance of the interests involved.

As a further illustration of the aid rendered national officials engaged in civilian work, the following is quoted from a letter written by Gen. J. P. Sanger, U. S. A., Director of the Philippine Census:

> Since January 1, 1903, almost the entire correspondence of the Bureau has been by telegraph, and during this period I have sent and received nearly 10,000 telegrams and cable messages, many of them at great length and a large proportion of them in the Spanish language.
>
> With the exception of a few errors—due, no doubt, to idiomatic and obscure phrases, requiring occasional repetition—the work has been carried on with such skill and dispatch as to merit special commendation; and, before leaving Manila, I wish to express to the members of the Signal Corps performing the duties of telegraph operators my high appreciation of their efforts and of the excellent organization and administration of the telegraph service.

With regard to the facilities afforded to trade and commerce in the Philippines, it may be noted that in June, 1901, the Chief Signal Officer made arrangements which increased largely the telegraphic facilities available to merchants and others. Every office in the archipelago was opened for insular commercial communication, while 60 of the larger offices were accorded facilities for handling foreign cable messages. The tariff fixed was very low, being 2 cents per word for points on the island of origin and 4 cents per word for points outside. The receipts from all such commercial messages were deposited in the insular treasury. To sum up the conditions of operation in the Philippines, there were on July 1, 1903, 4,577 miles of wire, of which 3,105 were land lines and 1,472 submarine cables. Part of this system during the year was transferred to the civil government and part abandoned, so that on June 30, 1904, the Signal Corps was operating 2,052 miles of land line and 1,468 miles of cable, connecting in its general system 84 telegraph offices and 13 telephone offices, exclusive of the telephone exchanges in Manila and at military posts. In the operation and maintenance of this system there were on duty at the end of the year 9 officers, 1 detailed officer from the line of the Army, and 356 enlisted men of the Signal Corps, as well as 158 civilians, of whom 147 were natives of the Philippines. In the city of Manila the telegraphic and telephonic systems, on a single conductor basis of estimate, aggregated 174 miles of circuit, of which 123.4 was telephonic. The military telephone system embraced 211 telephones connected with one main central with a 100-drop switchboard in operation night and day, and two subcentrals operated 10 hours daily. The number of calls during the year was 291,997. Outside of Manila local telephone systems for military purposes had been established at 28 army posts and stations and had an aggregate of 38 miles of circuit and 229 telephones. In addition it is understood that the constabulary lines of the Philippines aggregated 4,203 miles, of which 172 were cable, 1,861 telegraphic land lines, and 2,170 telephone lines. In connection with these, 66 telegraph offices and 197 telephone offices and stations were maintained.

Alaskan telegraphs.—In Alaska, as well as in the Philippines, the United States Signal Corps has had an arduous and serious task to perform in establishing and maintaining telegraphic communication. To realize the extent of the territory covered in that region by the network it would be necessary to plot it on a map of the United States as stretching from Wyoming to the Bahamas. The cables used would stretch from Newfoundland to the coast of Ireland, and the land lines would extend from Washington to Texas. The entire construction included 3,625 miles, embracing 2,079 miles of cable, 1,439 miles of land line, and a wireless system of 107 miles. These operations include, moreover, a most extensive utilization of American material, apparatus, and skill in the field of submarine work. The seamless rubber cable of American manufacture laid by the Corps between Sitka and Seattle is 1,070 miles in length, laid at an average depth of 1,000 fathoms and at an extreme depth of 1,700 fathoms, and it is said to have a transmitting power greater by 25 per cent than the amount of capacity arrived at in accordance with a mathematical calculation on the basis of the transatlantic gutta-percha cables, while in its original cost the former was less expensive than the latter. The cable in Alaska has been thrown open to public use and operated most successfully. The other extensive portion of the Alaska cable system—the Sitka-Valdez section—is 640 miles in length. These cables are operated by Signal Service operators, employing the latest Cuttriss syphon recording instruments. The following sections, aggregating 2,128 miles, are now installed and in operation in Alaskan waters:

	Miles.
Skagway to Fort William H. Seward	21
Fort William H. Seward to Juneau	102
Juneau to Sitka	291
Seattle to Sitka	1,070
Sitka to Valdez	640
Valdez to Fort Liscum	4

If the Norton sound cable, which has been abandoned, be included, a total of 2,260 miles of submarine cable has been laid in the waters about Alaska. The land line system of Alaskan telegraphs, nearly 1,500 miles in length, was scarcely completed when in June, 1903, extensive forest fires in the valley of the Tanana destroyed various portions of the circuits, aggregating 100 miles in length. The line was rebuilt, however, and thrown open to the general public for commercial service before winter began. It has since been operated with unusual success, although the difficulties are serious and exceptional, as a result of high gales, inaccessibility, the rigors of winter, etc. No fewer than 206 breaks, due mostly to blizzards, forest fires, high winds, and sleet storms, have had to be made good.

The Norton sound section of Alaska has been the scene of the development by the Signal Corps of a wireless system necessitated by the apparent inability to maintain permanent cable connections between Cape Nome and St. Michael. In the late summer of 1903 the wireless bases for Norton sound were established at Safety harbor and St. Michael, where portable houses were built, in which were installed engines, batteries, and wireless apparatus, supplemented at each station by two masts 210 feet high, between which were suspended fan-shaped antennae, consisting of 125 copper wires one foot apart. The generating plant comprises a 5-horsepower gasoline engine, a 3-kilowatt motor dynamo, a 60-cycle alternator, and step-up transformers. The transmitting and receiving apparatus operates successfully across a distance of 107 miles, and with it, in one afternoon alone, 5,000 words were exchanged between Safety harbor and St. Michael. Up to the present time this wireless system has sent over 1,000,000 words. It has been so successful that General Greely has recommended its extension to Dutch harbor or some other point in Unalaska, pointing out that the Signal Corps wireless station at Safety harbor could work to Nunivak Island to the south over the 250 miles of sea intervening, and that the Navy Department could, by stations of suitable power on Nunivak and Unalaska Islands, perfect communication over the balance of the distance, which is less than 400 miles. Similarly the signal station at Safety harbor could communicate readily with a wireless station at a suitable point on the Asiatic shore of Bering strait, thus completing the circuit around the world by that route, as was attempted and abandoned at the time when it was first proved that cable could be made operative across the Atlantic ocean.

During the year $56,935.89 was spent for Alaskan telegrams handled by the Signal Corps alone. Of this amount, there was collected on account of Alaskan line tariffs $12,208.93, which was deposited in the Treasury of the United States, as required by law. There was also collected and turned over to other lines the sum of $17,539.81. The balance, $27,187.15, was collected by other lines for tariffs on messages sent into and out of Alaska. Of the entire volume of business, amounting to 55,559 messages, there were 31,020 commercial and 26,539 official messages, the latter being chiefly telegrams connected with the transaction of Government business within the territory. With the recent additions to the facilities above described there has been a rapid increase of traffic.

United States cable ships.—It was found necessary that the Signal Corps should have a cable ship of its own for its submarine cable operations. With the cooperation of the Quartermaster-General of the Army, the transport *Burnside* has been utilized as a transport and as a cable ship in the Philippines and in Alaska. The efficiency of this transport was demonstrated during 1904 in picking up and laying cables in ocean depths ranging from one to two miles.

For several years past the repairing of Signal Corps cables along the Atlantic coast has depended upon the employment of commercial companies' cable boats, with the result that, despite every effort, cables connected with some of the most important defenses of the United States have been interrupted for long periods because of the inability to secure promptly a suitable boat by charter. During 1904 the Quartermaster-General of the Army purchased a boat, which has been named the *Cyrus W. Field*, and which is used by the Signal Corps for such work. The *Field* is fitted up with such cable apparatus as makes it an efficient and satisfactory boat for cable maintenance and repair.

Other telegraphic work of the Signal Corps.—Other work of a telegraphic character under the management of the Signal Corps comprises the operation of the telegraph and cipher bureau of the White House, which places the Commander-in-Chief of the Army and Navy in quick and direct communication with the military and naval forces of the United States.

A further development of the work of the Corps has been found in the organization of the Signal Corps of the National Guard. There exist, as shown by the 1904 report of the Chief Signal Officer, distinct organizations of this character, with commissioned officers and enlisted men, in California, Colorado, Connecticut, Illinois, Indiana, Iowa, Louisiana, Maine, Massachusetts, Nebraska, New Jersey, New York, Rhode Island, Texas, Utah, Washington, West Virginia, the District of Columbia, and the territory of Oklahoma; while detachments under noncommissioned officers have been organized in Maryland, New Hampshire, Rhode Island, and the territory of Arizona. These organizations are drilled in telegraphic technique and practice, are generally equipped with apparatus, and have shown themselves able to transact a considerable volume of telegraphic business during maneuvers and special operations of the National Guard.

Telegraphy in the Weather Bureau.—An important development of the official telegraphs of the United States has been that carried on by the Weather Bureau of the United States Department of Agriculture, with headquarters in Washington. An idea of the extensive nature of this work may be formed from the fact that on July 1, 1903, no fewer than 2,015 places in the United States were receiving daily forecasts, 926 were in receipt of special warnings, and 7,096 were in receipt of emergency warnings, all this work being done at Government expense. By means of the telephone 28,251 stations were in receipt of daily forecasts and 7,602 of special warnings, while in addition 3,087 points were reached daily by means of railway telegraphs, these being supplemented daily by an allied service by railway trains at 2,423 points, by mail at 78,164 points, and by rural free delivery service at 97,648 points. The data for this distribution were received in part through the cooperation of the principal telegraph companies, while the Weather Bureau had, at the date of its report in 1903, 421 miles of telegraph and telephone lines. The office operates also systems of submarine cable, as, for example, 9 miles from Key West, Fla., to the storm warning and vessel reporting station on Sand Key Island, Fla.; 23½ miles of submarine cable from Point Reyes Light, Cal., to Southeast Farallone Island, Cal.; and 8 miles of cable from Glenhaven, Mich., to connect with the storm warning display station on South Manitou Island, Lake Michigan. These are typical examples of the cable operations necessitated by the work of the Weather Bureau. The most notable extension to the work of the Bureau was made by means of the telephone, in regard to which Dr. Willis L. Moore, Chief of the Weather Bureau, in his report dated August 11, 1903, says:

> A marked increase (nearly 20,000) is shown in the number of places receiving forecasts by telephone without expense to the United States, and with the rapid extension of "farmers' telephone lines" (so called) opportunity is afforded for placing weather information directly in the homes of the more progressive agriculturists, as well as in the telephone exchanges of rural centers of population, where it is posted for the benefit of the general public. The managers of these local telephone lines seem to be very much interested in this matter, and, with very few exceptions, have given their hearty support in making the distribution as successful as possible. It is not difficult to secure the cooperation of these officials, as a statement of the fact that forecasts can be had gratis adds to the inducements which they can offer to prospective subscribers. The great advantages of this plan of dissemination are apparent when we consider the very early hour at which the production reaches the subscriber and the slight amount of labor involved in furnishing him with the information.

The weather map published by the Bureau summarizes daily in graphic form the telegraphic work done, being a photograph, so to speak, of weather conditions prevalent over the entire country. The record is taken daily at 8 a. m. and 8 p. m. at each of the 200 stations distributed over the 3,000,000 square miles, and embodies barometric and thermometric data, as well as observations relating to wind, rain, etc. At 8.30 p. m. these reports are dispatched to Washington, with the right of way over all other telegraphic business, and from them the map and the forecasts are developed each day at headquarters in Washington. The national capital is thus the central station from which the principal forecasts are sent out. Local forecasts are also issued at Chicago, Boston, New Orleans, Denver, San Francisco, and Portland, Oreg. The forecasts made for thirty-six or forty-eight hours are sent to the morning and afternoon papers and are published in 2,500 daily newspapers, in addition to the distribution given them as already noted. The promptness and value of the service may be inferred from the fact that in the middle Western states, from Ohio to Nebraska, 600,000 farmers obtain the morning weather forecasts by telephone thirty minutes after they are issued.

The total cost of the Weather Bureau is about $1,400,000 a year, and the careful investigation of an American insurance company has shown that the annual saving to the people of the United States by this telegraph and telephone weather service is $30,000,000. It is stated that during the cold wave of 1898 fruits valued at not less than $3,400,000 were saved by the telegraphic forecasts. With regard to shipping, also, the warning service has been of great utility, for forty-five minutes after the determination of a storm warning at Washington it is brought to the notice, or placed in the hands, of every sea captain in every lake and ocean port of the United States. It is stated that whereas formerly 75 per cent of the loss of the shipping on the Great Lakes was due to storms, now less than 25 per cent can be attributed to this cause on account of the efficiency of the storm warnings.

United States Life-Saving Service.—An important and valuable branch of telegraphic and telephonic work done by the National Government is that constituting the operations of the United States Life-Saving Service, conducted under the administration of the Treasury Department. This service does not now maintain, and never has maintained, any telegraph lines. The telephone is used exclusively between the life-saving stations in preference to the telegraph; for it is more convenient, its use is more easily learned, special operators are not required, and its maintenance is easier. As is well known, the stations of the Life-Saving Service extend along the coast of the United States at intervals of but a few miles, so that the whole seaboard is under patrol, and news of a shipping disaster or similar occurrence at one point can be immediately communicated to contiguous stations and the necessary aid obtained. The first lines of the Service were established in 1879, and the system has been gradually extended along the various coasts until, according to the statement of Mr. S. I. Kimball (for many years General Superintendent), there are now more than a thousand miles of line connecting stations with each other where they are contiguous and geographically related, and connecting isolated stations with the nearest local telephone exchange. The termini of all the lines running along the coast are either connected with or in the immediate neighborhood of the general telegraph systems of the country, so that messages can be promptly transferred from the telephone lines to the telegraph lines and sent to any part of the country. The utility of this service is frequently tested, not only in the communication of news to the press, but also in case of shipwreck, in enabling anxious friends and relatives to get in touch with each other with a minimum of agonizing doubt and delay.

Upon the plan above outlined, the country, or coast, is divided into 13 districts. The region of the Great Lakes is an exception to the plan, there being no system of continental lines connecting station with station, except in a few cases where such an arrangement can be advantageously effected. Most of the stations, however, are connected with telephone exchanges, giving long distance facilities in addition to local service.

All the telephone lines of the Service are constructed and maintained by a superintendent of telephone lines, with the aid of a corps of seven linemen, distributed over the various coasts of the country as the necessities may require. These linemen, however, are assisted in their duties by the life-saving crews, when such assistance can be rendered without interfering with their regular duties. It is difficult, if not impossible, to give an adequate idea by figures of the amount of work performed by the telephone corps attached to this service. These men, it may be said, are incessantly on duty, ready to meet the emergencies brought about by the shifting of beaches along the coast, the cutting through of gullies and inlets by severe storms, the strokes of lightning, and other troubles that tend to the interruption of constant communication over the circuits. As an illustration of the importance of the system, the following passage may be quoted from the official pamphlet entitled "Organization and Methods of the United States Life-Saving Service," published in 1894:[1]

> The telephone lines which now extend along nearly all those portions of the coast on which contiguous stations are located make it easy to quickly concentrate the crews of two or more stations at any point where additional force is required, as in the case when several wrecks occur at the same time in the same neighborhood, and the double equipment at each station expedites this concentration by permitting the reinforcing crew to come unencumbered. A notable illustration of the benefit of such a combination of crews was the work achieved near Cape Henlopen in the great storm of September 10, 11, and 12 last, one of the most destructive that has ever visited our coast, when the crews of three stations, under the leadership of Captain Clampitt, of the Lewes Station, rescued the crews of 22 stranded vessels—194 persons—by the use of every form of rescuing appliance, 23 being landed with the surfboats, 16 with the self-righting lifeboat, 135 with the breeches buoy, and 20 with the life car—not a life being lost.
>
> The telegraph and railroad systems of the country are also used to secure the services of the crews at scenes of rescue far remote from their stations. On two occasions the Cleveland crew has been called to Cincinnati, Ohio, and Newport, Ky., a distance of 240 miles, to render aid to the sufferers from inundations in the Ohio valley. On the first occasion, 1,200 persons were succored; on the second, over 800. The crew of the Sturgeon Bay Ship Canal Station, Lake Superior, was once called at night to Chocolay Beach, near Marquette, Mich., a distance of 110 miles. Proceeding by special train running at the highest attainable speed, and taking with them their beach apparatus and boat, they reached the beach at midnight, and, through a blinding snowstorm and in spite of bitter cold, were able to board two stranded vessels and rescue 24 persons after every effort of the citizens had failed. Shorter journeys of from 15 to 30 miles by rail are frequently undertaken, especially where the railway skirts the shore, as it does on many parts of the coast.

[1] By Sumner I. Kimball, General Superintendent of the Service. Read before the committee on life-saving systems and devices, International Marine Conference, November 22, 1889; pages 28 and 29.

CHAPTER III.

HISTORY AND DEVELOPMENT OF TELEGRAPHY.

Pioneers of telegraphy.—From the earliest dawn of civilization there has been an insistent effort to develop and perfect means of communication for the exchange of intelligence. The fundamental idea of society is that of intercourse, and it might be said that the place of any people in the scale of civilization may be determined by the extent to which it has cultivated and perfected its facilities for intercommunication. Among some of the most barbaric and primitive races, however, ingenious methods for signaling have long been known, and in the earliest historical records of the leading nations of antiquity are to be found frequent notes of the speed with which dispatches could be sent, signals exchanged, and warnings given over great expanses of country by various noises, columns of smoke by day, bonfires on mountain peaks by night, and other devices, some of which to-day remain as obscure in their nature as they appear to have been certain in their results. Many instances are noted in which the news of a great event has apparently been circulated hundreds of miles away simultaneously with its occurrence. From the scientific standpoint it seems certain that in the strict sense of the term no telegraphic agency intervened and that in each case the rumors were nothing more than the expression of natural foreboding or instinctive prophecy. Dismissing telepathy from consideration, it would seem that the earliest systematic telegraphic work was that done by means of signaling semaphores, which to this day remain extensively in use on railroads and frequently under electrical control.

With regard to the use of electricity or magnetism, Galileo, in 1632, referred to an occult art by means of which sympathetic magnetic needles, though widely separated, could be made to exchange signals for purposes of communicating intelligence, but this was merely the echo of a tradition or superstition that had come down from the ancients.

The discovery of an electrostatic discharge from a body electrified by friction was eagerly seized upon as a means of signaling, and as early as 1727 Stephen Gray made an electric discharge from an excited glass tube situated at one end of the line, to pass over a circuit some seven hundred feet in length, suspended in the air by silk threads, and thus effect the motion of a pith ball electroscope located at the other end. It was obvious that the delicate movements of the electroscope could be made to constitute a system of signals. Twenty years later Professor Watson constructed a telegraph line that extended from the rooms of the Royal Society of London over the house tops and used the earth as the return circuit. He employed the discharge of a Leyden jar or condenser as the current for operating the crude signals. A year later Benjamin Franklin sent crude signals across the Schuylkill river at Philadelphia. Cumulative results from these experiments set many minds working upon the problem of an electric telegraph, and in 1753 a practical suggestion of this nature was made by an unknown correspondent of the Scot's Magazine, who advanced the idea of having parallel wires corresponding to the letters of the alphabet extended between two given places. In 1774 an actual working telegraphic line of this kind was established at Geneva, Switzerland, by Le Sage, who had 24 wires, insulated in glass tubes, buried in the earth, and employed an ordinary frictional machine to deliver a charge to the wires. Such work remained, however, purely experimental and fruitless until the discovery of the primary voltaic battery by Volta enabled investigators to dispense with the use of frictional machines and placed in the hands of inventors and physicists a readily available source of current.

From this new point of departure successful advances were soon made. In 1812 Professor Soemering, of Munich, brought out an electro-chemical telegraph which was highly ingenious. Employing the discovery of the power of a current from a battery to decompose water, he caused the passage of the current over the circuit to evolve gas in the appropriate tube at the other end of the line, thus indicating any one of the 35 numerals and letters. About the same time similar work was done independently by Doctor Coxe, of Philadelphia, the signals being distinguished at the far end of the line through the decomposition of water or of a metallic salt. Ingenious as these methods were, it is obvious that a telegraph system comprising between 30 and 40 circuits and depending for its signals upon the evolution of a tiny bubble of gas could never be very practical. Another German, Schweigger, reduced this ponderous system of 35 wires to 2, the letters being indicated not simply by the bubbles, but by the time elapsing between their appearance. A remarkable step forward was made in 1816 by Ronalds, of England, who invented a telegraph system in which he used clocks, one at each end of an underground wire. In front of each clock was suspended, from an insulated wire, a pith ball electrometer. These balls were discharged as a brass plate or hand capable of being moved along the signal disk was made to touch a given letter, so that a series of signals could thus be transmitted equivalent to letters or numerals. Ronalds worked a line not less than 8 miles in length, but the transmission was slow. Upon the communication of his plan to the British Admiralty, he was informed that "telegraphs of any kind are now wholly unnecessary" and that "no other than the one now in use would be adopted." The English Government at this time was using semaphoric telegraphs, which had been improved by an Englishman named Murray from the telegraphs of like character employed by the French.

A significant advance was made in 1819, when the physicist Romagnesi discovered the deflecting influence of a galvanic current on a free magnetic needle, causing it to take a position at right angles to the flow or direction of the current; the direction of the current being reversed the deflection of the needle was also reversed. This and the great discovery by Oersted of the production of magnetism by electricity served as the basis of the needle telegraph system, as well as the groundwork of all modern telegraphy.

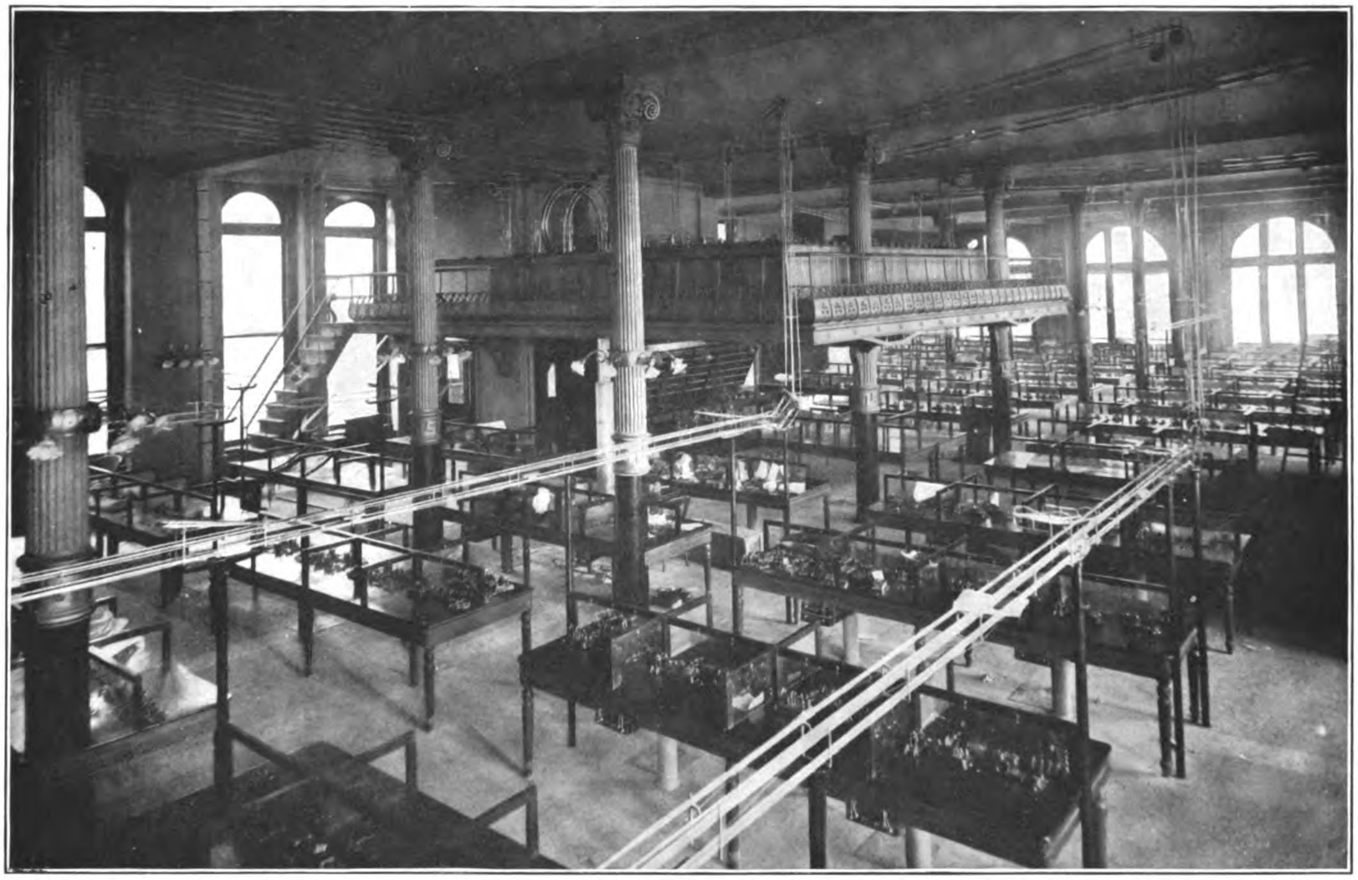
In 1820 Ampère, in a memoir to the Royal Academy of Sciences of Paris, disclosed the plan of an electric telegraph which depended on the deflection of a magnetic needle surrounded by coils of wire through which the currents were passed. He remarked significantly that the communication between the battery and the different coils was to be opened and closed by means of keys, but he still based his apparatus upon the employment of as many wires and magnetic needles as there were letters. In 1820 Schweigger made the interesting discovery that the deflection of the needle might be increased by coiling an insulated wire as a helix and thus conducting the current around the needle from end to end; while in 1821 Arago noted that a piece of soft iron thus surrounded by a helix of wire, when a current of electricity was passed through it, became a temporary magnet. In 1825 Sturgeon, of London, found that by loosely coiling copper wire around a varnished piece of insulated soft iron bent into the form of a horseshoe, the successive coils being insulated from each other, he could at will, upon passing a current through these coils, convert the soft iron into an electro-magnet and could as quickly demagnetize it. This provided means for reciprocal motion and for so controlling the movements of an armature in front of the electro-magnet that it acted in response to current impulse from a distant point, thus giving signals that might be taken by either the eye or the ear, or even be impressed upon paper. It will be seen that, while no practical telegraph had yet been brought out, successive experimental steps had developed the sources of current, effective circuits, and electro-mechanical and electro-chemical means, so that, by forces liberated or utilized at one end of the circuit, signals could be received and recorded at the other end many miles away.

The year 1837 was a notable one in the history of telegraphy, for the reason that Wheatstone and Cooke, in England, utilizing the work of Oersted and his contemporaries, devised an operative needle telegraph with right and left deflection, and put it into actual service in 1838 on the line of the London and Blackwall Railway, one of the first of England's steam railroads. They employed two conductors and two needles. At almost exactly the same time Steinheil, in Germany, discovered that a good electric connection could be made with the ground at each end of a single line, so that the return circuit or wire was no longer needed, while the resistance of the line was greatly reduced.

Simultaneously Morse, in America, was doing his great work, and in 1837 was able to make a public exhibition of apparatus whose conception dated back to 1835. Prof. S. F. B. Morse was a man of typical American versatility, one of the fathers of American art, as well as one of the founders and the first president of the National Academy of Design. His fame rests, however, upon his electro-magnetic telegraph, and, while his share in this and even his originality has been bitterly contested and the essentials of the art have been claimed for his distinguished associates, Professors Henry and Alfred Vail, it is impossible to deny that from Morse sprang the original conception and that by him much of the original work was done. Through struggle and privation his persistent and persevering efforts carried the invention to the point where it became a practical and invaluable art. The status of Morse in regard to the telegraph has been admirably set forth as follows by the late James D. Reid:[1]

> Morse's entrance into the circle of inventors was sudden and unexpected. . . . He was a painter, educated indeed in general electric science to the extent attainable by collegiate instruction and intimacy with professional teachers, but having never pursued its study with reference to practical results. He entered now not so much to discover, although even in this he has earned a permanent fame, as to invent and combine. He brought into use the painter's art . . . the blending, the combining of things known. He took familiar elements, and, with a dexterity which looks like inspiration, put them together. He then invented a language by which they could find expression. Up to his time it is well known that there had been practically no telegraphic language. Morse gave the alphabet of that language, and it is to-day acknowledged and employed by all nations as the telegraph idiom of the world. There was also, as all know, up to Morse's time no recording telegraph. Morse also gave that, and it is in preferential use by every nation on the earth.

[1] The Telegraph in America, page 77.



A MAIN OPERATING TELEGRAPH ROOM.

AUTOMATIC REPEATER EQUIPMENT IN TELEGRAPH OPERATING ROOM.

With regard to another important step, the relay, Reid[1] has also the following:

Morse made his discovery with the relay in 1836. It was the discovery of a means by which the current which through distance from its source had become feeble could be reinforced or renewed by its own action. It made transmission from one point on a main line, through indefinitely great distances and through an indefinite number of branch lines, and to an indefinite number of stations and registration at them all, by the manipulation of a single operator at a single station, both possible and practicable.

It was not until 1837 that two of his instruments were put in operation at the ends of a short line. In the earlier stages of his work Morse had thought it necessary to embody the signs to be recorded or printed in a kind of type which would regulate the opening and closing of the circuit, in order to mark or imprint corresponding points or signs upon a card or strip of paper at the desired intervals of time. For this purpose he made a quantity of type, some few pieces of which are still preserved, but in his more perfected apparatus this plan was abandoned.

In 1837 Morse filed his caveat in the United States Patent Office and six months later applied for a patent, which he obtained in 1840. His first completed instrument for recording was tested in 1835, and a model of the relay was shown to a few persons in that year and in 1836. The apparatus shown to Alfred Vail in 1837 was already in such promising and operative condition that the offer of pecuniary and mechanical assistance was immediately made to Morse by the Messrs. Vail, for which assistance Morse assigned to Vail one-fourth interest in the patents. A Morse instrument made at the Speedwell iron works of the Vail family at Morristown, N. J., was put in experimental operation over three wires of copper circuit carried around a room, and on January 24, 1838, this apparatus was shown in operation at the University of New York in Washington Square. A few weeks later it was inspected by the Committee of Science and Arts of Franklin Institute, whose report may be taken as authoritative of the stage of development and as evidence of the fact that telegraphy had reached a practical stage. The report says:

The instrument was exhibited to them in the hall of the institute, and every opportunity given by Mr. Morse and his associate, Mr. Alfred Vail, to examine it carefully and to judge of its operation. The instrument may be briefly described as follows: (1) There is a galvanic battery of sixty pairs of plates, set in action by a solution of sulphate of copper. (2) The poles of this battery can be connected at pleasure with a circuit of copper wire, which in the experiments we witnessed was 10 miles in length. The greater part of the wire was wound round two cylinders, and the coils insulated from one another by being covered with cotton thread. (3) In the middle of this circuit of wire—that is, at what was considered virtually a distance of 5 miles from the battery—was the register. In this there is an electro-magnet made of a bar of soft iron bent into the form of a horseshoe, and surrounded by coils of the wire which forms the circuit. The keeper of this magnet is at the short end of a bent lever, at the end of the longer arm of which is a fountain pen. When the keeper is drawn against the magnet, the pen comes in contact with a roll of paper wound round a cylinder, and makes a mark with ink upon this paper. While the telegraph is in operation, the cylinder which carries the paper is made to revolve slowly upon its axis by an apparatus like a kitchen jack, and is, at the same time, moved forward, so that the pen, if constantly in contact with the paper, would describe a spiral or helix upon its surface. (4) Near the battery, at one of the stations, there is an interruption in the circuit, the ends of the separated wire entering into two cups, near to each other, containing mercury. Now, if a small piece of bent wire be introduced, with an end in each cup, the circuit will be completed, the electro-magnet at the other station will be set in action, the keeper will be drawn against it, and the pen will make a mark upon the revolving paper. On the other hand, when the bent wire is removed from the cups, the circuit will be interrupted, the electro-magnet will instantly cease to act, the keeper will, by its weight, recede a small distance from the magnet, the other end of the lever will rise and lift the pen from the paper, and the marking will cease. (5) The successive connections and interruptions of the circuit are executed by means of an ingenious contrivance for depressing the arch of copper wire into the cups of mercury, and raising it out of them. This apparatus could not be described intelligibly without a figure, but its action was simple and very satisfactory. (6) Two systems of signals were exhibited, one representing numbers, the other letters. The numbers consist of nothing more than dots made on the paper, with suitable spaces intervening. Thus . . .   . would represent 325, and may either indicate this number itself, or a word in a dictionary, prepared for the purpose, to which the number is attached. The alphabetical signals are made up of combinations of dots and of lines of different lengths. There are several subsidiary parts of this telegraph which the committee have not thought it necessary to mention particularly. Among these is the use of a second electro-magnet at the register, to give warning by the ringing of a bell, and to set in motion the apparatus for turning the cylinder. The operation of the telegraph, as exhibited to us, was very satisfactory. The power given to the magnet at the register, through a length of wire of 10 miles, was abundantly sufficient for the movements required to mark the signals. The communication of this power was instantaneous. The time required to make the signals was as short, at least, as that necessary in the ordinary telegraphs. It appears to the committee, therefore, that the possibility of using telegraphs upon this plan in actual practice is not to be doubted, though difficulties may be anticipated which could not be tested by the trials made with the model. One of these relates to the insulation and protection of the wires, which are to pass over many miles of distance to form the circuits between the stations.

In 1837 Morse had made a report to the Secretary of the Treasury of the United States with regard to his telegraph system, and in the following year it was exhibited before the President of the United States and his Cabinet. Morse now attempted to secure aid from Congress for the construction of a line about 40 miles in length between Washington and Baltimore, and finally a bill was passed by a small majority appropriating $30,000 for this purpose. This line was duly constructed, and on May 24, 1844, Miss Ellsworth, daughter of the United States Commissioner of Patents, sent over it the memorable message, "What hath God wrought!" A short while afterwards the National Democratic Convention, sitting in Baltimore, nominated Polk for President, and the immediate transmission of the news by telegraph to Washington not only caused a sensation, but helped the young

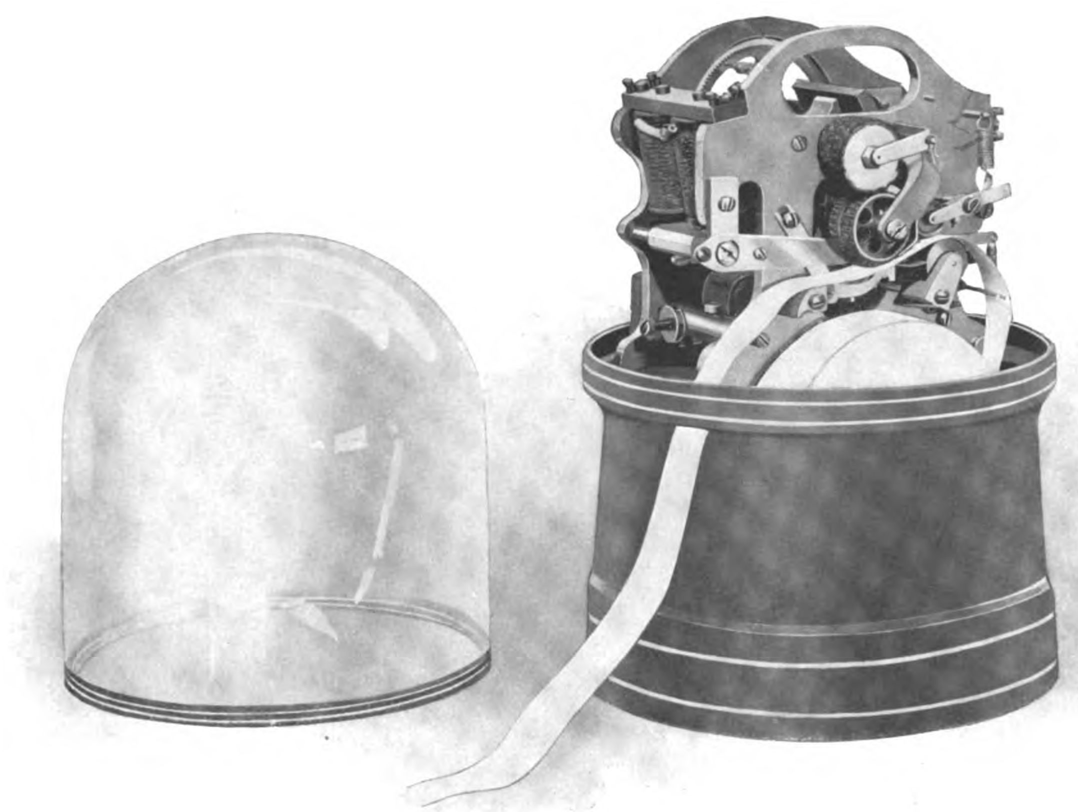
[1] The Telegraph in America, page 78.

invention in many other ways. During the session of 1844–45 Congress made an appropriation of about $8,000 to keep the system in operation during the year, and placed it under the supervision of the Postmaster-General. A tariff of one cent for every four characters was instituted, and Messrs. Alfred Vail and J. H. Rogers were appointed operators under Professor Morse as superintendent. The Government declined, however, to go any further in its assistance, and also refused to purchase the Morse telegraph for $100,000, the price at which it was offered by the inventor and his associates. Thus, contrary to the practice prevailing in Europe, the telegraphs reverted to private hands and have so remained up to the present time.

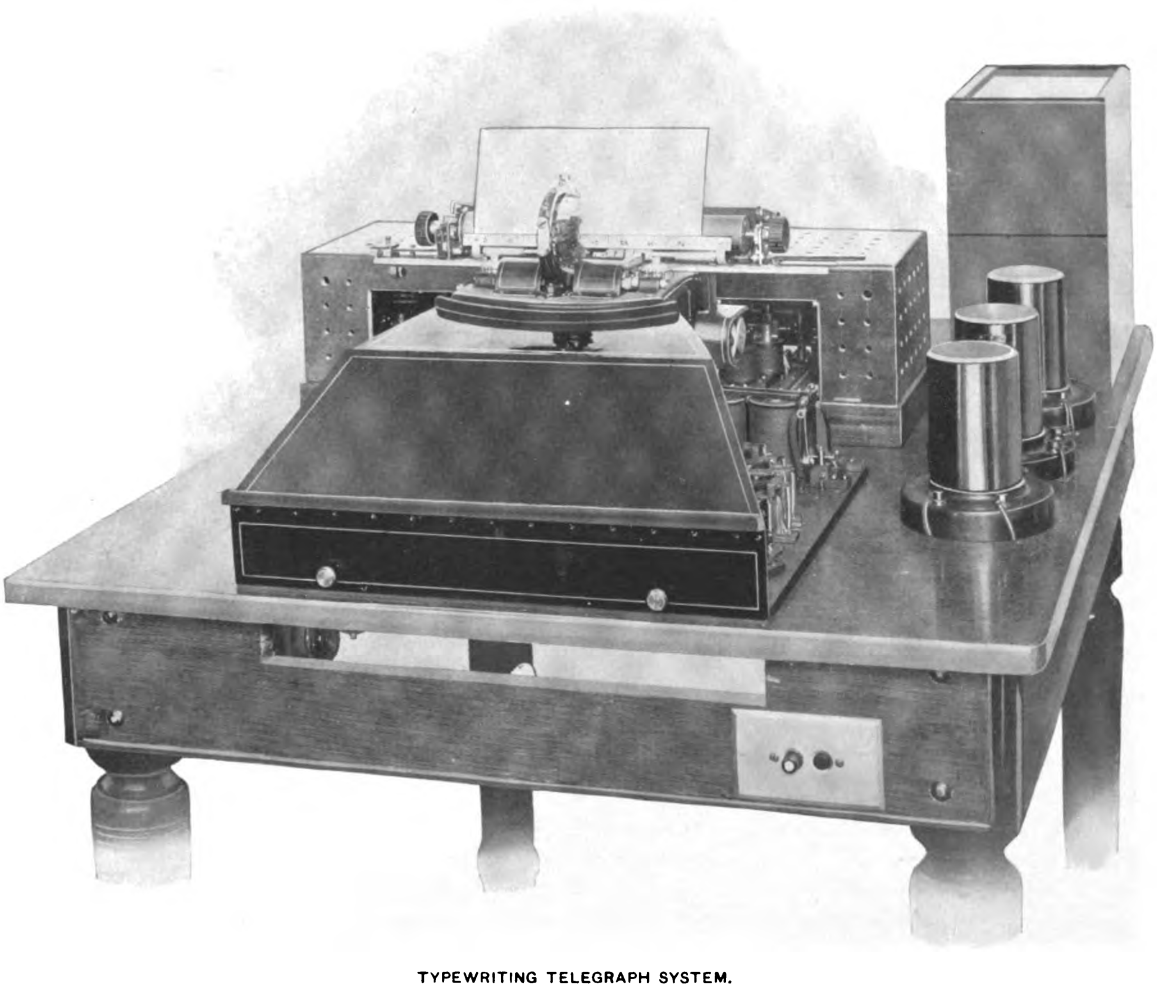
Commercial developments.—The early days of telegraphy as an industry in the United States witnessed the usual difficulties and disasters that every new art encounters. The growth of business was naturally attended also by a great many rivalries and competitions. The first chapter of the American commercial telegraphic development, summing up all the pioneer work of whatever character, may be said to have closed with the formation of the Western Union Telegraph Company, which in 1856 consolidated a large part of the telegraphic systems of the country. No sooner had Morse shown his system to be operative and succeeded in enlisting capital than other inventions and devices also found their supporters, and it took several years before the chaos of conflicting claims and methods could be reduced to system and the best types of apparatus could establish their superiority. The Morse system has always been based essentially upon the operation of a lever key, the depression and raising of which, opening and closing the circuit, causes a series of longer and shorter electrical impulses to pass over the wire, thus making corresponding clicks with the sounder or imprinting themselves on tape as dots and dashes, the nature and sequence of which translate themselves into letters and numerals.

But from the very first other principles competed with this simple manual plan, and some of them remain operative to the present day, though, strange as it may seem, after three-quarters of a century of tremendous electrical development the whole great telegraphic system of the world is still based primarily and essentially upon the skill of the human hand—i. e., upon manual operation as distinguished from mechanical transmission. In other words, telegraphy remains a handicraft. Machine telegraphy was, however, like chemical telegraphy, given a very early trial, and some of the companies competing with the Morse system based their claims to public support upon the employment of printing apparatus, such as the Hughes and Phelps, and, perhaps more notably the House, upon which patents were granted in 1846 and in 1852. Some idea of the ability of the House mechanism may be formed from the fact that its capacity has been rated at from 1,800 to 2,600 words an hour; indeed, a press report containing 3,000 words, more or less abbreviated, has been sent by it in the same time. Two men were required for the reception or transmission of such a message, one known as the "grinder," to give the machinery motion by turning a crank, and the other to act as the operator. Some of these operators became so expert and highly trained that, even when the type wheel was performing at the rate of 6,000 revolutions per hour, they could calculate the variation of time between strokes, and read messages on the House printer from the sounds these made.

Such automatic or machine printing systems have attracted attention from time to time, and several are now before the public as competitors for favor. None of them, however, has been able to secure the enthusiastic approval of telegraphic authorities in America, although elaborate and continued experiments have been made over long circuits, and the only one in general employment outside of the Morse system is the more or less antiquated Wheatstone, in which messages are prepared by perforating tape by hand punches, the tape being afterwards run through machines permitting signals to be transmitted, which, upon being taken off at the other end of the long circuit, give a record in dots and dashes in ink on a strip of stiff paper. A speed of 400 words a minute is attainable with the perforated tape run through a Wheatstone automatic transmitter at high speed, the receiver at the distant end giving a clear and distinct impression of the signals. This speed is, however, only attainable on circuits of moderate length, say 200 miles of overhead line. As compared with such rapid work the average rate by hand of from 25 to 50 words a minute seems very slow. This slowness is offset, of course, by the time spent by the Wheatstone operator in preparatory punching; but an enormously increased amount of telegraph business can be transmitted by the machine method over the same wire, and great economy is thus obtained in the time during which the circuit is occupied for the transmittal of a message. The assertion is made by the advocates of automatic and high speed telegraphy that, given favorable conditions, such systems would enable a large proportion of the mail matter now sent by trains to be put on the wires with enormously increased expedition. Thus the written contents of a whole mail bag from New York to Chicago, if handled by automatic or machine telegraph, could be sent over the circuit between the two cities in one or two hours, so that a letter written at the seaboard in the morning could be delivered to a merchant on the banks of Lake Michigan before his lunch hour. Automatic high speed telegraph systems, in which speeds of 1,500 to 2,000 words per minute are attained, have usually employed at the receiving end chemically prepared paper, upon which the current by its decomposing effect traces the



NEW FAST STOCK TICKER.



TYPEWRITING TELEGRAPH SYSTEM.

dots and dashes of the Morse alphabet. One of the chemical solutions used for this paper is iodide of potassium, the current setting free the iodine, which appears as brownish characters upon the paper strip.

The inventors of automatic systems maintain that all this is feasible and should have been carried out long ago; while, on the other hand, the managers of large telegraph systems, although permitting their wires to be used for such experimental work, assert that the practical difficulties are too serious to be overcome, and that the key and the sounder associated with the Morse alphabet remain to-day the necessary foundation of the commercial telegraphic art. With one of the modern machine telegraphs, the ingenious Buckingham system, over one and a half million messages have been transmitted, and a record has been made of 2,429 words between New York and Chicago in slightly less than twenty-four minutes. In this system the messages are actually received in typewritten form on message blanks and are thus ready for instant delivery.

One striking improvement has been the invention of duplex, quadruplex, and multiplex telegraphy. In duplex telegraphy two distinct messages are simultaneously transmitted in opposite directions over a single wire. In diplex, two messages are transmitted over one wire at the same time in the same direction. The next step made was due largely to the work of Edison, and was that of enabling one wire to carry two messages at the same time from each end of the line. A number of working circuits in America are thus quadruplexed, and the "phantom circuits" thus created effect an enormous saving in line construction. It has, indeed, been asserted that such saving amounts to as much as fifteen or twenty millions of dollars in the United States alone.

A number of multiplex telegraph systems have been brought out, although very few are apparently operative or in practical use. Among the most notable are those with which the names of Gray and Delany have been associated. Some depend upon musical tones, which serve as the vehicle of an equal number of separate telegraphic messages. These tones are sent over the line in the form of rapid interruptions of current obtained by means of tuning forks, vibrated automatically by electro-magnets. Such harmonic systems, although admirable as beautiful inventions, have no prominent place in the art.

A more practical development which has been carried out on both sides of the Atlantic consists of the synchronous system in multiplex telegraphy, such as that of Delany, in which trailing fingers or arms passing over the face of disks at each end of the line are maintained in synchronous relationship. The single line wire between the two disks is led to the different portions of each disk in such a manner that as the two arms travel around they can distribute electrical impulses successively to each section. Through this division or dissection of the line, say into as many as thirty-six separate parts, it is feasible to transmit with virtual simultaneity 36 separate messages. This ingenious system has never been pushed to quite such an extent, but it has been found possible to send several messages simultaneously in both directions. Obviously either the arm may travel or the disk upon which it makes contact may revolve, the result in each case being the placing simultaneously in contact of corresponding parts of the disk, so as to give the sectors and the operators working them momentary use of the wire in swift succession.

Aside from methods of sending dispatches, a great deal of experiment was devoted in the early days to the insulation of circuits. The idea of burying wires underground was taken up at the very outset, but the practice was soon adopted of raising the wires attached to insulated arms, brackets, or knobs on poles. In this exposed position, especially in wet and foggy weather, the current leakage from the line rendered the effective transmission of signals very difficult. Both copper and iron wire was used in the first circuits, but copper was soon abandoned on account of undue elongation and lack of tensile strength, and iron wire came into common use. On many circuits the iron wire was fastened to the bare poles with iron staples, such poor insulation resulting that the cutting down of every second pole was actually carried out in order to render the line operative. Some of the circuits were insulated with tar; in one or two cases they were coated with beeswax. In a short time insulators fastened to the cross arms by wooden pins were developed. As early as 1848 one of the contracts for circuits in Maryland, to be built at a cost of $300 a mile for a single wire line, specified that there should be 20 poles to the mile; that the wire should be three-ply, No. 14 iron wire, painted when put up, insulated with square glass globes set in the end of the poles, with a glass cover and with a wooden one 10 inches square, the poles themselves to be of white oak, chestnut, or cedar. The number of poles was soon raised to 35, but this appears in other respects to have been fairly standard construction. At a very early stage, before 1850, neat iron poles were adopted at Louisville. A very early form of insulation was a small iron hat, into which an iron stem with a hook was inserted and was held until hot brimstone in the hat had cooled and solidified around it. About 1849 No. 9 galvanized iron wire was adopted for some of the circuits in New England, associated with cylindrical glass globes for insulators. These globes were secured by an iron stem and hook to a wedge of wood insulated with gum shellac. Some of the earliest circuits consisted of several strands of No. 16 iron wire, twisted into a cord, the idea being to increase both strength and conductivity; but it was soon found that this form retained moisture, which caused oxidation and disastrous weakness. Other early attempts at insulation and the construction of durable circuits comprise the adoption of vulcanized rubber as insulating material in place of glass, and short poles of only 10 or 12 feet, so as to avoid high winds and atmospheric electricity. It was soon found, however, that vulcanite exposed to the atmosphere became foul and fragile, and that the shorter poles, half the length of the ordinary, were exposed to the dangers of spring freshets, while the wires could not be carried clear of buildings, etc., which would not constitute an obstacle to circuits at the ordinary height.

Submarine telegraphs.—The attempts to transmit signals commercially through wires laid under water date back as far as 1839. In the summer of 1842 Morse laid an insulated wire in New York harbor between Castle Garden, at the southern extremity of Manhattan Island, and Governors Island, the United States military headquarters at the junction of the East and North rivers. He employed a wire wrapped in hempen thread, well soaked with pitch and tar, and surrounded by rubber. A few signals were exchanged over this circuit, but the cable was torn up, as a great many of its successors have been, by the anchor of a boat and part of it was carried off by the sailors. This experiment was repeated at Washington in the following December and both experiments are described in a letter of Mr. Morse to the Secretary of the Treasury, dated December 23, 1844. Numerous other experiments were made in the next few years in the United States. The first submarine wire insulated with gutta-percha in this country was laid across Hudson river in 1849 from New York city to the New Jersey shore. This wire or cable having no protection other than the gutta-percha the circuit soon broke down and was abandoned. The first submarine cable of any length antedated this a year, having been laid in 1847 across the strait from Dover, England, to Calais, France, the cable consisting of a copper conductor, surrounded merely by an insulating layer of gutta-percha.

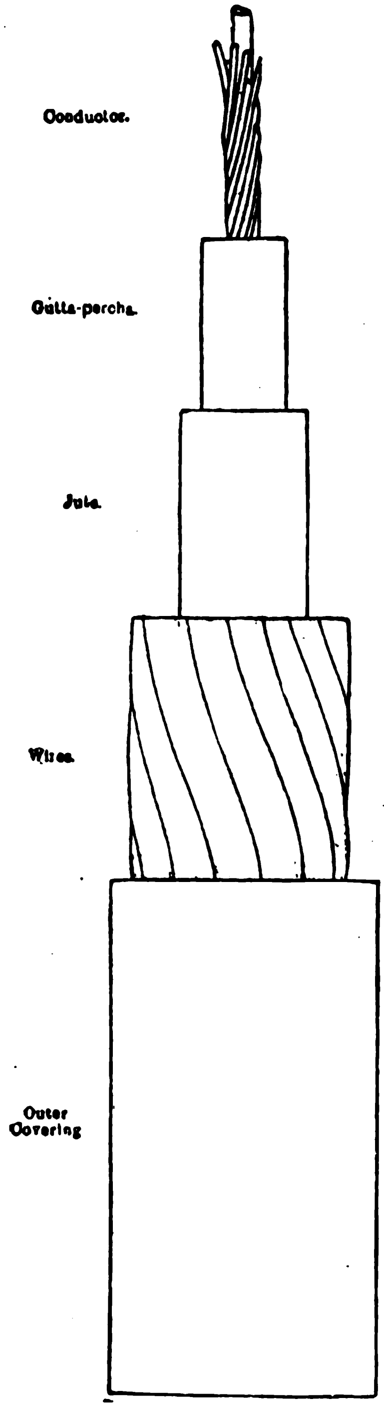
Although the early failures were somewhat discouraging, the more sanguine inventors and scientists were convinced that such work could be indefinitely extended. Morse said with regard to data obtained from his own trials, "The practical experience from this law is that telegraphic communication on the electro-magnetic plan may certainly be established across the Atlantic ocean. Startling as this may now seem, I am confident the time will come when the project will be realized." The same idea appealed to many minds, but it was not until numerous shorter lengths of cable had been laid in different parts of the world, particularly those connecting England with the continent of Europe, that the larger project was pushed forward. The successful carrying out of the idea was in great measure due to the courage and indomitable perseverance of a young New York merchant, Cyrus W. Field, who associated with himself such well-known Americans as Peter Cooper, Moses Taylor, and Marshall O. Roberts. Capital was pledged, Government support was enlisted, on both sides of the Atlantic surveys were made, and in 1858 the first Atlantic cable was laid between Ireland and Newfoundland. Congratulatory messages were exchanged between Queen Victoria and the President of the United States, and the public enthusiasm on both sides of the Atlantic was intense.

Very little was known, however, about the conditions governing the construction of cables to be lowered to and raised from such extreme depths as 2,000 fathoms, and this first cable linking the New World with the Old lasted but a few weeks. Its sudden lapse into silence caused many people to be skeptical as to whether messages had actually been exchanged. As a matter of fact, exactly 400 messages had been transmitted between August 5, the day it was connected on both sides of the ocean, and September 1, the time of its interruption. Such a failure, following a long series of other ruptures and interruptions, was enough to paralyze all further effort, but the courage of Mr. Field and his associates rose superior to every obstacle, and the work was renewed in 1865, when another cable was laid across the Atlantic, only to break again in deep water before completion. A final effort was made in 1866, when a third cable was successfully and permanently laid on the bed of the ocean, while the cable laid the previous year was recovered and repaired in deep water, so as to become available for business. By this time about $12,000,000 had been invested, all of which would have been totally lost had the attempt failed, so that one need hardly grudge the handsome rewards which were enjoyed by most of the parties in the enterprise when at last their efforts brought fruition.

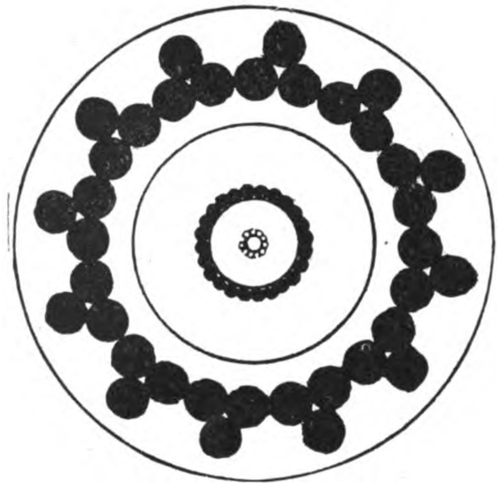
Since 1866 the history of submarine telegraphy has been one of continuous advance, until all the oceans have been occupied by these circuits. The last definite figures with regard to cables give the number as 1,750, with an aggregate length of nearly 200,000 miles, their cost being estimated at $275,000,000 and the number of messages transmitted annually over them at more than 6,000,000. The fleet maintained for laying and repairing these cables in all quarters of the globe would constitute a fair-sized navy, and several large factories in the leading countries of the world are devoted exclusively to the production of submarine cable.

Submarine cables.—Considerable progress has been made in the production of submarine cable, although of late years the chief changes have been in the direction of increasing the weight.

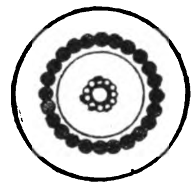
At the present time such cable, as shown in illustration on page 117, consists broadly of a central core or conductor of stranded copper wire, over which is a



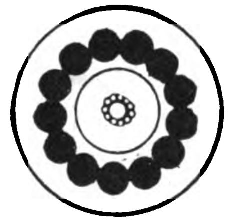
Submarine Telegraph Cable, with various layers stripped.



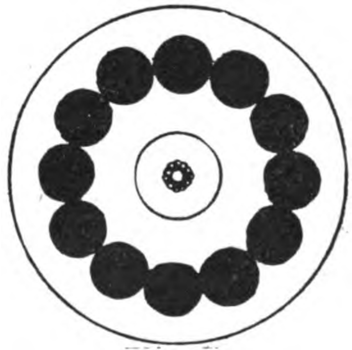
Shore-end Cable.



Deep-sea Cable (for greatest depth).



Deep-sea Cable (for lesser depth).



Intermediate Cable.

TYPES OF SUBMARINE CABLES.

18407—06——9

layer of insulation consisting usually of gutta-percha or a gutta-percha compound. These constitute the cable proper, but are protected by a wrapping of jute or hemp, around which is placed an external sheathing of stranded iron or steel wires covered with tape and compound. The core of the cable varies in size and weight of copper according to the length of cable and the speed at which it is proposed to send signals through it. A small core permits only a slow rate of transmission, while a large one allows a high rate of speed to be obtained over the longest cable. The copper core in a modern cable will weigh as much as 650 pounds per nautical mile, with an electrical resistance of nearly 1¾ ohms the mile. In the earlier cables the gutta-percha insulation weighed about as much as the copper—that is, 400 pounds to the mile—which is now about the standard weight for the gutta-percha.

Such a cable can be worked over a distance of 1,850 nautical miles, or 2,130 statute miles, at a speed of 40 words, or about 200 letters, per minute, but lighter cables do not permit of such a high efficiency. When worked duplex, the carrying capacity of the cable is approximately 80 words, or 400 letters, per minute. The shore end or shallow water portion of such cables weighs about fifteen tons to the mile and receives especially heavy armor on account of exposure to abrasion by rocks, ice, etc.; but the deep sea portion weighs only one ton to the nautical mile in water, with a breaking stress of six tons, so that it would support at least six miles of its own weight when immersed. The cable to be laid is carried to sea in lengths of several hundred miles, coiled up in large tanks, from which the cable is paid out by means of a special, highly ingenious gear and sheaves which permit the operation to be checked at any minute. Should the work of laying the cable be interrupted—as, for example, by fog or storm, or on the approach to shore—the end is buoyed so that it can be picked up. Cable can be paid out at a speed of four to eight miles an hour, according to its size, the state of the weather, etc. In some of the earliest work ruptures were frequent, but at the present time cable laying is usually conducted with great celerity, even in the Pacific ocean, where depths of 5,000 or 6,000 fathoms are reached.

Submarine signaling.—While regular telegraphic signals can be transmitted over short lengths of cable, their use is impracticable with long submarine cables, and hence other means have to be adopted of causing the electrical impulses to pass from one end to the other. It might be supposed that strong and large currents would be required, but the contrary is really the case, and apparatus of the most delicate character is employed, while the volume of current is very small. Cable messages are transmitted in two ways. In one the mirror galvanometer is used. The movements of a mirror carried on the needle of the galvanometer deflect a small beam of light over a scale marked on a sheet of white paper. A current passing in one direction through the galvanometer coils deflects the spot of light to the left, while a current passing in the opposite direction deflects it to the right. When the needle is still, the reflected beam of light from its little mirror forms a bright motionless spot on the paper; but a very minute movement of the mirror is considerably amplified by reflection, and the operator finds it easy to read the signals thus sent by the cable keys at the other end of the line. Such receiving apparatus is extremely light in weight, the mirror and the magnet weighing only from one and one-half to three grains, so that the passage of an extremely small current through the galvanometer coils will transmit visible signals.

It can readily be understood that such processes, while ingenious, are easily susceptible of interruption, and that the strain upon the operator, watching in the dark, the movement of the dot of light, is quite trying. Moreover, no record is left. The other form of apparatus, due primarily, like the cable mirror galvanometer, to Lord Kelvin and known as the syphon recorder, has very generally superseded the mirror galvanometer, and this gives a record. In this apparatus the moving member affected by the passage of current through adjacent coils carries a delicate glass syphon, one end of which dips into a reservoir of ink, while the other end is brought very near to the surface of a traveling paper tape. The ink discharged from the syphon as it moves to and fro makes a permanent record on the tape in a series of strokes looking like the line of a serrated mountain ridge, the dots being represented by upward movements and the dashes by downward movements. In the Kelvin syphon recorder, in order to compel this ink to flow out of the syphon, both the ink and the paper are oppositely electrified, the effect being to cause the ink to be ejected so as to produce a line of minute dots. The recorder sometimes failed to operate in damp weather, owing to the dissipation of the electrostatic charges on the paper and ink, but Cuttriss has successfully overcome this difficulty by keeping the syphon in constant vibration by means of electromagnets in the circuit.

Wireless telegraphy.—The aim in wireless telegraphy is to establish electrical communication between two stations without the use of wires for conveying the impulses of the current. In its more modern acceptation the term is limited to aerial or space telegraphy, depending upon the use of the ether as distinguished from some of the earlier work in which bodies of water were used as media for conveying signals. Such utilization of water dates back to the time of Franklin, who in 1748 made some experiments across the Schuylkill at Philadelphia, while in 1842 Morse transmitted signals across an 80-foot canal without wires. In such experiments the actual media for conveying the current were water and earth, which, like the wires, are tangible substances rather than intangible, like the tenuous ether.

This work was resumed in a more practical manner nearly half a century later by Mr. Edison and other inventors in connection with train telegraph systems, the object of which is to communicate with a moving train remote from stations or signaling points. One means of accomplishing this consisted in a sliding or rolling contact with the train, like the trolley now employed in street cars. But the fundamental idea of wireless train telegraphy being the absence of contact, the Edison and other systems depend on electromagnetic or electrostatic induction for the transmission of signals. Special apparatus installed in the signaling station sends currents at a high rate of pulsation over wires paralleling the track along which the train passes. These impulses are transmitted to the passing train by means of either coils of wire wound lengthwise around the car or, preferably, a metallic roof or side on the car. This metallic surface thus acts as one large plate of a condenser. The signals sent are readily received, and messages can be sent in like manner from the moving train to the parallel circuits along the track. In such work it has been usual to employ a telephone as the receiver of the usual dots and dashes as well as the telegraph key and buzzer, and it is stated that messages have been sent through the air in this manner between a fixed circuit and a moving train through a distance as great as 600 feet. Similar methods have been worked out by Mr. Edison and others for communication with ships at sea, with balloons, etc. A full account of such ingenious methods can be found by those interested in Maver's "American Telegraphy and Encyclopedia of the Telegraph."

The wireless telegraph systems of the present day and of the period embraced in this report utilize the free ether of space. The mechanism consists of apparatus for creating electro-magnetic vibrations which are propagated at the speed of light in all directions and are of various wave lengths. These electro-magnetic waves are analogous to the vibrations imparted to the surrounding air by a sonorous bell or tuning fork or to the ripples which, when a stone is dropped into a body of water, follow each other in rapid succession in every direction until the whole impulse has died out. Sound waves travel at the rate of 1,120 feet a second, and the number of vibrations to the second depends upon the wave length of the note struck. Such a rate of speed is very slow compared with that of wireless telegraphy, for, accepting the electro-magnetic theory of light, from the fact that light travels at 186,000 miles per second, it is seen that the etheric transmission of an electro-magnetic wave is practically instantaneous for telegraphic purposes. Wireless telegraphy depends on the ability of the apparatus at the receiving end cf the line to respond sympathetically to the vibrations of the ether, just as objects attuned to the same fundamental note respond when a tuning fork is struck in its vicinity.

One of the first significant demonstrations of the existence and passing of these electric waves in space was made by Prof. Joseph Henry, who, by means of disruptive spark discharges from a frictional electrostatic machine on an upper floor of his house, succeeded in magnetizing needles in the cellar 30 feet below, in spite of the two floors and ceilings intervening. The definite discovery of these radiations came much later, however, and was made in 1888 by the late Heinrich Hertz in Germany. Similar studies had been made in England by Oliver Lodge, S. P. Thompson, and others. As early as 1885–86 apparatus was patented whose operation depended upon the effect produced upon particles of dust, etc., by the electric oscillations. This was a primitive form of the coherer action, more closely identified and developed by Branly, and finally worked out by G. Marconi in his now well-known system of wireless telegraphy, patents for which were applied for in June, 1896.

In the Marconi system the electro-magnetic waves, produced by special high tension disruptive discharge apparatus and given off to the ether by means of wire antennae carried up into the air for a considerable distance, are intercepted at the remote receiving station by similar high wire antennae and brought down for registration to a coherer. This coherer consists of a small glass tube about the size of an ordinary pocket pencil. In this tube are two pole pieces of silver, to which the wires of the circuit run, and between them is a gap of about one thirty-fifth of an inch loosely filled with a mixture of nickel and silver filings or particles, to which a little mercury has been added to increase the sensitiveness. The arriving electric oscillations have the effect of drawing the filings together to form a continuous circuit, so that the resistance within the tube, high when the filings are loose, is diminished when they cohere, and a current then flows from the local battery. This closing of the coherer circuit closes also the telegraphic recording circuit. At the instant that the impulses received make their record the tongue, or tapper, of an electromagnetic bell gives the tube a sharp jolt, which causes the particles to separate, and the tube is ready to receive the waves constituting the next signal. When the apparatus is properly tuned for receiving the waves, messages can be regularly transmitted and clearly received.

In March, 1899, after preliminary experiments over shorter distances, Mr. Marconi established wireless telegraphic communication between South Foreland, England, and a station near Boulogne, on the other side of the strait of Dover. His disruptive apparatus consisted of a 10-inch induction coil, by means of which he caused sparks to pass across a spark gap of about three-fourths of an inch. The waves that resulted from the electrical disturbance were given off into the ether by copper wire antennae raised by a pole 150 feet into the air. Messages were sent and received by the Morse code at the rate of 15 words a minute, the distance being 32 miles. Prof. J. A. Fleming, who was present, says: "The messages were automatically printed down in telegraphic code signals on the ordinary paper slip at the rate of 12 to 18 words a minute. Not once was there the slightest difficulty or delay in obtaining an instant reply to a signal sent." This work attracted a good deal of attention, but was eclipsed by that done on December 12, 1901, when Mr. Marconi succeeded in transmitting the three successive dots which constitute the letter *S* of the Morse alphabet clear across the Atlantic from the permanent Marconi station at Poldhu, Cornwall, to a temporary station at St. Johns, Newfoundland. One year later regular dispatches were transmitted over the same etheric route, including congratulatory messages between King Edward VII and the Governor-General of Canada.

Since that time considerable news matter has been sent across the Atlantic by the Marconi system, but up to the time of the preparation of this report no regular commercial service had been established. Meantime, however, the Marconi and De Forest systems have been installed in a large number of Atlantic steamships, which are thus enabled to communicate with tower stations along the shores of the Old World and the New and carry on in the aggregate a considerable wireless telegraphic traffic. The steamships also maintain telegraphic communication among themselves for business purposes, and the writer of this report was able to witness, in March, 1905, the maintenance of communication between five such steamships in mid-Atlantic, the two extreme members of the group being 1,000 miles apart.

In the United States, as in Europe, the development of wireless telegraphy has been quite rapid; systems of great ingenuity and merit have been elaborated and commercially established by Dr. Lee De Forest, Prof. R. A. Fessenden, John S. Stone, and others. All the navies of the world have adopted wireless telegraphy of some kind, and, in addition to the systems named, the "telefunken" is in quite general use for such purposes in Europe as well as commercially. In that of the United States have been elaborated improvements enabling men-of-war to communicate over distances of hundreds of miles. The main desideratum at the present time is the means of placing transmitting and receiving stations in exclusive connection, so that no others can intercept the dispatches.

The best work done with wireless telegraphy up to the present time has been across large bodies of water rather than on land, and various ingenious theories are advanced to account for this phenomenon. Remarkable results have nevertheless been secured on land. Mr. Marconi, in Europe, has transmitted messages from England across the continent of Europe to Italy, and during the Louisiana Purchase Exposition in 1904 Doctor De Forest transmitted messages from St. Louis to Chicago. During the late Russo-Japanese War a very considerable use was made of wireless telegraphy by both combatants, and it was also used most successfully by the London Times, whose special correspondent on board a small steamer equipped with a De Forest apparatus was able to send dispatches from the scene of action around Port Arthur direct to the Chinese coast. This work was, however, stopped summarily by the Russian military authorities, and the important question of the right of a newspaper or any neutral to establish within the sphere of conflict means of communication which could be used to the serious disadvantage of one or the other of the powers at war has, with cognate matters, become the subject of diplomatic discussion.

PART III

MUNICIPAL ELECTRIC FIRE ALARM AND POLICE PATROL SYSTEMS

PART III.

MUNICIPAL ELECTRIC FIRE ALARM AND POLICE PATROL SYSTEMS.

ELECTRIC FIRE ALARM SYSTEMS.

The statistics included in this report cover practically all municipal electric fire alarm systems in operation in the United States during any part of the year ending December 31, 1902. No previous inquiry of the kind has been made in the United States serving as a basis of comparison, and the present inquiry was restricted to systems depending upon the application of the electric telegraph or telephone. The present report deals with electric fire alarm systems and police patrol systems, which are frequently worked together in common by one board or department, but which are here treated, as far as possible, in separate categories; no cognizance was taken of fire brigades, engines, etc. The data presented refer exclusively to systems operated under municipal control, with the exception of the fire alarm system in use at the Rock Island Arsenal, Illinois, which is owned and operated by the United States Government.

The earliest records dealing with the subject show that fire alarms and fire extinction were matters which until the last century were left very largely to private and volunteer effort. But even in the days when the fire apparatus was manned by organized citizens or by persons acting upon the impulse of the moment, the appliances and the alarm systems were often owned or subsidized by the communities. Thus, fire wardens appear among the officials of New York city as early as 1683, since which time there has been a steady tendency to remove fire administration from private hands and concentrate it in those of the municipality. Nevertheless the present report, which includes the statistics of 764 systems, shows wide variations in the municipal methods adopted for the government of the fire alarm and fire extinction service. The boards or departments of administration to which these systems were intrusted are shown in Table 1.

TABLE 1.—*Electric fire alarm systems, grouped according to boards or departments of administration: 1902.*

BOARDS OR DEPARTMENTS OF ADMINISTRATION.	Systems.
Total	764
Administrative bodies	341
Board of aldermen and police and fire commissioners	1
Board of assessors	2
Board of commissioners for public utilities	10
Board of fire commissioners (or commissioner)	62
Board of fire engineers	67
Board of public safety	36
Board of public works	6
Board of selectmen and board of engineers	1
Board of trustees elected by voluntary firemen	2
Chief of fire department and city electrician	2
City council and chief of fire department	4
City council and fire marshal	5
City council and superintendent of fire and police departments	1
Committee appointed by citizens at town meetings	2
Department of electricity	21
Department of fire and police patrol telegraph	1
Department of police and public property	1
Department of wire inspection	2
Fire and police board	1
Fire and water committee of the sanitary improvement commission	1
Fire department (chief, committee, or director of)	141
Fire marshal	2
Joint board of fire wardens and selectmen	1
Mayor and city council	20
Mayor, city council, and fire department	1
Ordnance Department of United States Army	1
Police and fire commission	12
Police and fire department	1
Superintendent of fire alarm and police patrol telegraph	4
Water department	1
Water and light department	1
Not reported	10

From Table 1 it appears that 341 fire alarm systems, or nearly 50 per cent of the total number, were under the direction of administrative bodies; these included boards of aldermen, boards of selectmen, city councils, boards of burgesses, trustees, etc.—bodies which are almost universally of an elective character. In the larger cities of the United States, however, it is now an almost invariable rule that the fire department shall be administered by an officer or officers nominated and appointed by the mayor, with or without the confirmation of the city council. There is also a growing tendency to intrust the supervision of the fire alarm and police patrol systems, as well as of other electrical functions, to a department of electricity.

The authorities, other than administrative bodies, in charge of fire alarm systems include 141 fire departments, 67 boards of fire engineers, 62 boards of fire commissioners (or a single commissioner), 36 boards of public safety, 21 departments of electricity, 20 mayors with the assistance of the city council, and 12 police and fire commissions. This heterogeneity is due largely to the fact that so many of the fire alarm systems are in cities and towns of less than 25,000 population.

Table 2 shows the number of fire alarm systems installed during each year, from 1852 to 1902, inclusive.

TABLE 2.—*Electric fire alarm systems installed each year.*

YEAR.	Number.	YEAR.	Number.	YEAR.	Number.
Total	764	1886	22	1868	10
		1885	23	1867	4
1902	25	1884	11	1866	2
1901	19	1883	17	1865	3
1900	26	1882	10	1864	1
1899	25	1881	3	1863	....
1898	33	1880	10	1862	1
1897	32	1879	8	1861	....
1896	32	1878	5	1860	....
1895	36	1877	3	1859	....
1894	37	1876	6	1858	1
1893	53	1875	7	1857	....
1892	41	1874	8	1856	....
1891	50	1873	9	1855	1
1890	44	1872	3	1854	1
1889	44	1871	6	1853	....
1888	40	1870	9	1852	1
1887	38	1869	4		

It will be observed from Table 2 that in the earliest decade, namely, from 1852 to 1862, only 4 systems of fire alarm telegraph were installed. From 1862 to 1872 greater activity was evinced, 40 systems being installed. The decade from 1872 to 1882 showed a still further increased appreciation and demand on the part of the public, no fewer than 62 systems being installed. The rate of increase was well maintained from 1882 to 1892, these ten years witnessing the installation of no fewer than 299 systems, or about 30 per year. In the eleven years from 1892 to 1902, inclusive, the number of new systems was proportionately greater, reaching 359, or nearly 33 new plants per year. In view of the fact that all the larger cities had already been equipped, the swelling number would indicate that as time has gone by the improvements of the system and the increasing introduction of automatic features have rendered the service available for many of the smaller communities.

No census records prior to 1902 are on file with regard to the municipal electric fire alarm systems of the United States, so that comparison with the statistics presented in Table 3 is not possible. This table shows the construction and equipment and number of fire alarms for cities of specified population.

TABLE 3.—ELECTRIC FIRE ALARM SYSTEMS, GROUPED ACCORDING TO POPULATION OF CITIES, AND THE PERCENTAGE EACH ITEM IS OF TOTAL: 1902.

	POPULATION GROUPS.						PER CENT OF TOTAL.				
	Total.	100,000 and over.	50,000 and under 100,000.	25,000 and under 50,000.	10,000 and under 25,000.	Under 10,000.	100,000 and over.	50,000 and under 100,000.	25,000 and under 50,000.	10,000 and under 25,000.	Under 10,000.
Number of systems	764	36	37	76	221	394	4.7	4.9	9.9	28.9	51.6
Overhead construction:											
Miles of pole line—											
Owned	2,798	869	350	262	524	793	31.1	12.5	9.4	18.7	28.3
Leased	10,952	2,682	1,123	1,818	2,877	2,452	24.5	10.2	16.6	26.3	22.4
Wire mileage—											
Total	28,202	14,172	2,755	2,866	4,475	3,934	50.3	9.8	10.1	15.9	13.9
Single wire	27,721	13,849	2,738	2,837	4,369	3,928	50.0	9.9	10.2	15.8	14.1
Single wire in cables	481	323	17	29	106	6	67.2	3.5	6.0	22.0	1.3
Underground construction:											
Street miles of conduit—											
Owned	414	378	19	5	10	2	91.3	4.6	1.2	2.4	0.5
Leased	445	316	46	25	51	7	71.0	10.3	5.6	11.5	1.6
Wire mileage—											
Total	11,433	10,647	461	127	177	21	93.1	4.0	1.1	1.6	0.2
Single wire	526	387	42	36	55	6	73.6	8.0	6.8	10.5	1.1
Single wire in cables	10,907	10,260	419	91	122	15	94.1	3.9	0.8	1.1	0.1
Number and character of boxes or signaling stations:											
Signaling	37,739	16,028	3,787	4,665	7,159	6,100	42.5	10.0	12.4	19.0	16.1
Number on poles or posts	34,776	14,880	3,357	4,242	6,609	5,688	42.8	9.6	12.2	19.0	16.4
All other	2,963	1,148	430	423	550	412	38.7	14.5	14.3	18.6	13.9
Annunciating	93	....	....	....	16	77	....	....	....	17.2	82.8
Number on poles or posts	84	....	....	....	16	68	....	....	....	19.0	81.0
All other	9	....	....	....	....	9	....	....	....	....	100.0
Special telephones	1,900	1,432	125	163	115	65	75.4	6.6	8.6	6.0	3.4
Fire alarms received	85,070	40,548	8,760	11,716	15,499	8,547	47.7	10.3	13.8	18.2	10.0
Central office equipment:											
Manual transmitters	155	91	10	18	25	11	58.7	6.5	11.6	16.1	7.1
Automatic transmitters	295	29	45	76	103	42	9.8	15.3	25.8	34.9	14.2
Receiving registers, all kinds	452	165	49	84	80	74	36.5	10.8	18.6	17.7	16.4
Receiving circuits	1,973	752	289	344	426	162	38.1	14.7	17.4	21.6	8.2
Transmitting circuits	1,361	440	265	259	297	100	32.3	19.5	19.0	21.8	7.4
Telegraph switchboards, number	214	55	21	35	71	32	25.7	9.8	16.3	33.2	15.0
Number of sections	259	84	25	36	81	33	32.4	9.7	13.9	31.3	12.7
Total capacity	2,407	1,401	212	225	463	106	58.2	8.8	9.4	19.2	4.4
Telephone switchboards, number	62	39	9	7	5	2	62.9	14.5	11.3	8.1	3.2
Number of sections	153	105	28	8	10	2	68.6	18.3	5.2	6.6	1.3
Total capacity	6,480	5,911	374	86	56	53	91.2	5.8	1.3	0.9	0.8
Single circuits	442	....	....	4	97	341	....	....	0.9	22.0	77.1
Central station power equipment:											
Engines—											
Number	7	2	1	....	1	3	28.6	14.3	....	14.3	42.8
Horsepower	58	50	2	....	1	5	86.2	3.5	....	1.7	8.6
Dynamos—											
Number	19	2	1	1	3	12	10.5	5.3	5.3	15.8	63.1
Horsepower	51	32	2	2	4	11	62.8	3.9	3.9	7.8	21.6
Motor generators and dynamotors—											
Number	81	58	8	3	5	7	71.6	9.9	3.7	6.2	8.6
Horsepower	47	22	3	9	5	8	46.8	6.4	19.2	10.6	17.0
Battery cells—											
Primary	57,010	23,189	4,735	4,793	10,713	13,580	40.7	8.3	8.4	18.8	23.8
Storage	49,327	16,364	10,469	8,960	9,629	3,905	33.2	21.2	18.2	19.5	7.9

Table 3 shows a total of 764 systems, of which 36 were in cities having a population of 100,000 and over, 37 in cities of 50,000 and under 100,000, 76 in cities of 25,000 and under 50,000, 221 in cities of 10,000 and under 25,000, and 394 in cities and towns under 10,000. These systems had in the aggregate 2,798 miles of pole line owned and 10,952 leased, with a total wire mileage of 28,202 miles, consisting of 27,721 miles of single wire and 481 miles of single wire in cables, engaged in the receipt and distribution of fire alarms. That the practice of putting such important wires as those of the fire alarm telegraph underground has rapidly increased of late years is indicated by the fact that, in addition to this overhead construction, these systems included 414 miles of conduit owned and 445 miles leased by municipalities, giving shelter to 11,433 miles of wire, of which 526 miles were single wire and 10,907 miles were wire in cables; thus, out of a total wire mileage of 39,635 miles, 28.8 per cent was underground.

Distributed along the circuits thus enumerated, there were reported 37,739 signaling boxes or stations, of which 34,776 were installed on poles or posts, and 2,963 "all other," or those located in booths, buildings, etc. There were also 93 annunciating boxes reported. It has already been shown that there were 39,635 miles of wire in the systems, and as the total number of signaling stations and annunciating boxes was 37,832, the distribution of apparatus by means of which alarms can be sent in to the central office was evidently very nearly one to the mile of operative circuit. If to this signaling and annunciating apparatus be added the 1,900 special telephones reported, the stations would slightly exceed one per mile of wire. Over this apparatus and wire mileage 85,070 fire alarms are reported to have been sent or received during the year ending December 31, 1902, which would give an average of between two and three per station and per mile of wire. It will be understood, of course, that these figures for fire alarms sent in or received do not include retransmission from central over other circuits from headquarters to the scattered engine houses, hook and ladder companies, etc.; for this reason it is impossible to determine the aggregate number of alarms received, transmitted, repeated, etc., by the fire alarm departments. Nor can any definite inference be drawn with regard to the number of boxes per mile of circuit in regard to the density of population or of buildings, for the general reason that as a measure of safety and precaution it is the practice not to put adjacent boxes on the same circuit, the object being to prevent interruption of service on any given line of communication, and also to lessen the probability of any two boxes on the same circuit being "pulled" at once for the same fire.

Table 3 presents also a variety of data with regard to the central office equipment. By reference to the table it will be seen that there were 155 manual transmitters, 295 automatic transmitters, and 452 receiving registers of all kinds, grouped at the various central offices or fire headquarters. These were associated with 1,973 receiving circuits and 1,361 transmitting circuits, for the operation of which there have been installed 214 telegraph switchboards, with 259 sections and a total capacity of 2,407 circuits, working in cooperation with 62 telephone switchboards, with 153 sections, and a total capacity of 6,480 drops or lines. The single circuits extending from the headquarters and returning thereto were reported as 442 in number. There are a large number of so-called fire alarm systems that consist in ringing a central bell or merely blowing a shrill whistle at some well-known central point, and it is probable that such an arrangement exists in some localities for calling the police or the village constable. No so-called fire alarm or police patrol systems were considered by the Bureau of the Census as falling within the scope of the inquiry unless the calls were sent in through a box over a single circuit and received at a fire or police central where at least one receiving register or other device was located.

For the operation of the fire alarm systems reported a large variety of apparatus and methods are in use, although battery current is in all the main reliance and the chief source of energy supply. According to the returns included in Table 3, the central office power or current equipment in 1902 comprised 57,010 primary and 49,327 storage battery cells. The primary batteries are usually of simple type, depending merely upon the renewal of acid or of such materials as copper or zinc, and the storage batteries are charged, in most cases, from an exterior power plant. This is shown by the fact that among the 764 systems there were reported only 19 dynamos generating current, with a total capacity of 51 horsepower; 7 steam or gas engines, with a total capacity of 58 horsepower; and 81 motor generators and dynamotors, with a total capacity of 47 horsepower. From this it would also appear that certain of the dynamos generating current are engine driven, and that the others are driven by electric motors. In some instances the power plant installation is in the nature of a reserve or precautionary measure, to insure a supply of current to the circuits in case the ordinary sources of supply should be interrupted.

A further study of Table 3 reveals the fact that of the 442 single circuits all but 4 were reported for cities of less than 25,000 population, 97 being in cities of between 10,000 and 25,000, and 341 in cities of less than 10,000. Other details indicate that for the systems in cities of less than 25,000 population there is little central office equipment other than the receiving registers and automatic transmitters. Of the total underground wire mileage of 11,433 miles reported in 1902, 10,647 miles, or 93.1 per cent, were in cities having a population of 100,000 and over; a similar proportion prevailed with respect to conduits. The distribution of the 28,202 miles of overhead wire construction, however, was very different, 14,172 miles, or 50.3 per cent, being found in cities of 100,000 population and over, and 8,409 miles, or 29.8 per cent, in cities of less than 25,000 population. Distributed along these 8,409 miles of overhead wire were 13,352 signaling and annunciating boxes or stations, or 35.3 per cent of the total number. The use of the telephone appears to be chiefly restricted to the larger cities. Only 7 out of 62 switchboards, and only 109 out of 6,480 drops, or telephone lines, were reported in cities of less than 25,000 population; whereas 39 of the switchboards and 5,911 drops were reported in cities of 100,000 and over. In most other respects this table reveals a general uniformity and similarity of equipment and practice in the fire alarm systems throughout the country, as measured by the per cent distribution among the different population groups.

In connection with the use of the telephone for fire alarms it may be noted that it has been the practice of the Wisconsin Telephone Company, of Milwaukee, to suggest in its telephone directory that patrons send in fire alarms by telephone. The chief of police has lately requested the manager of the company to omit this suggestion from the book hereafter, for the reason that it frequently takes too long a time to notify the fire headquarters by telephone. This delay, he states, gives the fire a chance to gain headway before the department is able to respond to the call.

The percentage each item is of the total is also shown in Table 3. As might be expected, the percentages show that in the smaller communities, where for reasons of economy it is not feasible nor desirable to employ a large fire alarm staff, automatic transmitters preponderate, these percentages being 25.8, 34.9, and 14.2, respectively, in the three smallest population groups, whereas in respect to the use of manual transmitters 58.7 per cent are in use in the one group of cities having a population of 100,000 and over and nearly 80 per cent in the three groups comprising a population of 25,000 and over. It is rather surprising, however, to note that the smallest cities report the largest proportions of all engines and dynamos, which would hardly be expected since a primary battery equipment is usually quite adequate in such cases, but the numbers dealt with are altogether too small to carry any particular significance. In fact, it will be noted that 51 per cent of all primary batteries and 45.6 per cent of the total number of storage batteries were for systems in cities of less than 50,000 population.

Table 4 presents a synopsis of the number of fire alarm systems which reported the different varieties of construction and equipment, grouped according to population of cities.

TABLE 4.—*Electric fire alarm systems reporting different varieties of construction and equipment, grouped according to population of cities: 1902.*

CHARACTER OF CONSTRUCTION AND EQUIPMENT.	NUMBER OF SYSTEMS, BY POPULATION GROUPS.					
	Total.	100,000 and over.	50,000 and under 100,000.	25,000 and under 50,000.	10,000 and under 25,000.	Under 10,000.
Overhead construction:[1]						
Pole line—						
Owned exclusively	114	4	4	3	21	82
Leased exclusively	509	18	23	50	157	261
Owned and leased	139	13	10	23	43	50
Overhead construction exclusively	681	5	24	63	202	387
Underground construction:[2]						
Conduit—						
Owned exclusively	19	6	5	2	4	2
Leased exclusively	53	14	8	11	15	5
Owned and leased	9	9				
Both overhead and underground construction	83	31	13	13	19	7
Boxes or signaling stations:[3]						
Signaling boxes exclusively	752	36	37	76	220	383
Annunciating boxes exclusively	9				1	8
Both signaling and annunciating boxes	1					1
Special telephones	104	24	9	18	27	26
Central office equipment:						
Manual transmitters exclusively	43	16	1	5	13	8
Automatic transmitters exclusively	214	8	28	56	87	35
Both manual and automatic transmitters	43	12	8	9	11	3
Receiving registers, all kinds	182	29	20	32	53	48
Receiving circuits	322	35	37	72	124	54
Transmitting circuits	255	35	32	56	93	39
Both receiving and transmitting circuits	255	35	32	56	93	39
Telegraph switchboards exclusively	146	4	13	28	70	31
Telephone switchboards exclusively	21	11	3	2	4	1
Both telegraph and telephone switchboards	30	18	6	4	1	1
Single circuits exclusively	442			4	97	341
Central station power equipment:						
Engines	5	1	1		1	2
Dynamos	14	1	1	1	3	8
Motor generators and dynamotors	24	8	2	3	5	6
Engines, dynamos, motor generators, and dynamotors	1	1				
Dynamos, motor generators, and dynamotors	7	1		1	1	4
Battery cells—						
Primary	522	19	18	34	140	311
Storage	270	29	29	48	88	76
Both primary and storage	44	13	10	7	9	5

[1] One system failed to report the miles of pole line owned or leased, and one system failed to report pole line and wire mileage.
[2] Two systems failed to report the miles of conduit owned or leased.
[3] Two systems reported only telephoning boxes, which are not shown in this table.

From this interesting table it will be observed that of the 764 fire alarm systems in the United States, 681 used overhead construction exclusively, and of this number 387, or over 50 per cent, were to be found in communities of less than 10,000 population. This confirms the statement as to the extension of municipal fire alarm systems in the smaller cities and towns. There were 83 systems which used combined overhead and underground construction. There were only 114 municipalities which owned their entire pole line, while 509 leased, or used without cost, the supports for their overhead wires and cables.

Table 5 shows the miles of conduit and the wire mileage for the 83 systems reporting the use of underground construction.

Table 5.—UNDERGROUND CONSTRUCTION OF ELECTRIC FIRE ALARM SYSTEMS, BY STATES AND CITIES: 1902.

STATE OR CITY.	STREET MILES OF CONDUIT.		WIRE MILEAGE.		
	Owned.	Leased.	Total.	Single wire.	Single wire in cables.
United States	414	445	11,433	526	10,907
California	15	21	221	15	206
Los Angeles		10	54		54
Pasadena		1	2		2
San Francisco	15	10	165	15	150
Connecticut	30	8	143	127	16
Hartford	12		40	40	
New Britain	2		2	2	
New Haven	16	8	101	85	16
District of Columbia	1	6	760		760
Washington	1	6	760		760
Illinois	62	3	684		684
Bloomington	2		13		13
Chicago	54		640		640
Elgin		1	3		3
Evanston	6		24		24
Rockford		2	4		4
Indiana		5	58	3	55
Fort Wayne		1	6		6
Indianapolis		4	52	3	49
Maine		4	17		17
Portland		4	17		17
Maryland	(1)	(1)	42		42
Baltimore	(1)	(1)	42		42
Massachusetts	6	124	1,463	204	1,259
Boston	3	34	990		990
Brookline		19	50	31	19
Cambridge		1	3		3
Clinton		5	8	8	
Fall River	1		13		13
Haverhill		5	30	30	
Lexington		3	3	3	
Lowell		5	61		61
Milton		1	5		5
Nahant	1		1	1	
New Bedford		6	24		24
Newton		2	8	4	4
Springfield		18	120		120
Waltham		3	9		9
Westfield		3	3	3	
Winthrop	1		3		3
Worcester		19	132	124	8
Michigan	33	9	255	25	230
Bay City	3		7		7
Detroit	30		225	23	202
Jackson		3	10		10
Kalamazoo		3	7		7
Lansing		2	2	2	
Port Huron		1	4		4
Minnesota	2	19	315		315
Minneapolis	2	3	200		200
St. Paul		16	115		115
Missouri	4		455		455
St. Louis	4		455		455
Nebraska	(1)	(1)	23		23
Omaha	(1)	(1)	23		23
New Hampshire		5	14	2	12
Keene		1	2	2	
Nashua		4	12		12
New Jersey	1	18	156	2	154
East Orange		1	2		2
Long Branch		1	5		5
Montclair		1	1	1	
Morristown		1	1	1	
Newark		13	120		120
Paterson		1	24		24
Trenton	1		3		3
New York	134	30	1,380		1,380
Albany		3	25		25
Buffalo	2	5	168		168
Geneva	1		3		3
New York[2]	129	1	1,105		1,105
Rochester		13	50		50
Syracuse		3	15		15
Troy	2		4		4
Yonkers		5	10		10
Ohio		21	474		474
Akron		1	23		23
Canton		1	5		5
Cincinnati		9	195		195
Cleveland		5	80		80
Columbus		1	45		45
Toledo		4	126		126
Pennsylvania	85	137	4,353	53	4,300
Allegheny		84	252		252
Erie	2		11		11
Philadelphia	75	53	3,905	53	3,852
Pittsburg	8		185		185
Rhode Island	3	12	201		201
Newport		4	20		20
Providence	3	8	181		181
Tennessee		6	45		45
Memphis		6	45		45
Texas		7	26		26
Galveston		2	2		[3]2
San Antonio		4	20		20
Waco		1	4		4
Vermont		2	9	9	
Burlington		2	9	9	
Virginia		6	136		136
Norfolk		1	5		5
Richmond		5	131		131
Washington	2		2	2	
Seattle	2		2	2	
Wisconsin	36	2	201	84	117
Eau Claire	1		2		2
La Crosse		2	15		15
Milwaukee	35		184	84	100

[1] Not reported.
[2] Has 2 separate systems, but is treated as 1 system.
[3] City rents one or more wires in cable owned by private company.

It appears from Table 5 that in the 83 systems included, 414 miles of conduits were owned and 445 miles were leased, giving a total of 11,433 miles of single wire and single wire in cables from which the streets have immediately been released. This underground circuit was more widely distributed than might perhaps be expected, being found in no fewer than 23 states and the District of Columbia. Nor can it be said that the larger cities were unduly represented; a glance at the table shows that New York, Boston, Chicago, Philadelphia, and other large cities by no means preponderated in this respect. Further reference to this subject will be made incidentally in connection with underground police patrol wires.

Table 6 presents the number of employees and the total salaries and wages paid in 1902 in cities of 100,000 population and over in 1900, for both electric fire alarm and police patrol systems. Data are presented for 25 systems exclusively fire alarm, 21 systems exclusively police patrol, and 9 systems a combination of fire alarm and police patrol service, or a total of 55 systems.

TABLE 6.—*Employees and wages in cities of 100,000 population and over, electric fire alarm and police patrol systems: 1902.*

	Total.	Fire alarm exclusively.	Police patrol exclusively.	Combination fire alarm and police patrol.
Number of systems	55	25	21	9
Salaried officials and clerks:				
Total number	84	28	21	35
Total salaries	$139,477	$49,396	$32,294	$57,787
General managers, superintendents, etc.—				
Number	71	28	21	22
Salaries	$124,728	$49,396	$32,294	$43,038
Clerks and bookkeepers—				
Number	13			13
Salaries	$14,749			$14,749
Wage-earners:				
Total average number	818	305	291	222
Total wages	$804,065	$309,034	$270,903	$224,128
Operators, male—				
Average number	[1] 396	[1] 118	211	67
Wages	$401,659	$132,379	$201,204	$68,076
Foremen and inspectors—				
Average number	92	30	22	40
Wages	$100,666	$36,585	$20,361	$43,720
Linemen, wiremen, batterymen, etc.—				
Average number	289	123	54	112
Wages	$272,910	$114,945	$46,738	$111,227
All other employees—				
Average number	41	34	4	3
Wages	$28,830	$25,125	$2,600	$1,105

[1] Includes 1 female operator.

It will be gathered that the figures shown in Table 6 are representative rather than inclusive; at the same time they should not be understood as applying to the systems as a whole, owing to the fact that in so many of the smaller communities the duties which would fall to a fire alarm or police patrol service are merged in those performed by other officials in such a manner that the proportion of salaries or wages paid can not well be segregated according to the amount of work done or relative hours of duty in each department. The number of wage-earners shown in the table is the average number of each class continuously employed during the year in the operation and maintenance of the electrical department of the two systems.

Of the 38 cities having a population of 100,000 or over, 2—Kansas City and St. Joseph, Mo.—had no systems of electric fire alarm; 2 did not report employees and wages, the systems being operated by local telephone companies on contract; and in 9 the fire alarm and police patrol systems were operated in conjunction and were reported in combination. In regard to the police patrol service, 4 of the 38 cities having a population of 100,000 or over—Louisville, Ky., New Orleans, La., Scranton, Pa., and Toledo, Ohio—had no electric systems; 1 failed to report employees and wages, and 3 were operated by local telephone companies on contract. The systems for 9 cities, as already noted, were operated in conjunction with fire alarm services and were reported in combination therewith.

That the services are already of some magnitude is indicated by the fact that the 55 systems included in this table show a total of 84 salaried officials and clerks, with total salaries of $139,477 per annum, and 818 wage-earners, with total wages of $804,065 per annum.

Table 7 is a detailed statement summarizing for each state all of the information with regard to constructional equipment of fire alarm systems, and also the number of alarms received.

1, Automatic repeater; 2, automatic line tester; 3, multiple pen register; 4, manual dial transmitter.

1, Relay switchboard; 2, joker board; 3, working switchboard; 4, multiple pen register; 5, automatic line tester.

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TABLE 7.—ELECTRIC FIRE ALARM

	STATE OR TERRITORY.	Number of systems.	CHARACTER OF CONSTRUCTION.										NUMBER AND CHARACTER OF BOXES OR SIGNALING STATIONS.					
			Overhead.					Underground.					Signaling.			Annunciating.		
			Miles of pole line.		Wire mileage.			Street miles of conduit.		Wire mileage.								
			Owned.	Leased.	Total.	Single wire.	Single wire in cables.	Owned.	Leased.	Total.	Single wire.	Single wire in cables.	Total number.	Number on poles or posts.	All other.	Total number.	Number on poles or posts.	All other.
1	United States	764	2,798	10,952	28,202	27,721	481	414	445	11,433	526	10,907	37,739	34,776	2,963	93	84	9
2	Alabama	6	4	79	112	112							195	192	3			
3	Arizona	1	7		7	7							16	16				
4	Arkansas	2	7	19	37	37							62	62				
5	California	28	149	280	1,487	1,462	25	15	21	221	15	206	1,572	1,457	115	20	16	4
6	Colorado	12	42	145	219	219							397	368	29			
7	Connecticut	26	55	381	569	569		30	8	143	127	16	1,014	813	201			
8	Delaware	1		60	140	136	4						70	70				
9	District of Columbia	1	(1)	(1)	(1)	(1)	(1)	1	6	760		760	307	261	46			
10	Florida	7	6	48	88	88							179	178	1	8	8	
11	Georgia	8	67	97	197	197							410	406	4	2		2
12	Idaho	1	10		10	10							10	10				
13	Illinois	34	162	545	2,136	2,124	12	62	3	684		684	2,275	2,173	102	3	3	
14	Indiana	37	87	545	935	885	50		5	58	3	55	1,400	1,296	104	9	9	
15	Iowa	19	49	294	373	372	1						520	495	25			
16	Kansas	8	33	71	120	120							183	172	11			
17	Kentucky	12	29	149	299	299							587	464	123	16	16	
18	Louisiana	3		113	423	423							321	321				
19	Maine	22	11	227	367	366	1		4	17		17	481	443	38			
20	Maryland	3	8	13	170	170		(1)	(1)	42		42	493	491	2			
21	Massachusetts	106	311	1,791	3,867	3,808	59	6	124	1,463	204	1,259	4,890	4,385	505			
22	Michigan	40	210	327	940	910	30	33	9	255	25	230	1,531	1,468	63			
23	Minnesota	17	81	182	769	766	3	2	19	315		315	838	800	38			
24	Mississippi	4		25	40	40							52	47	5			
25	Missouri	3	83	38	1,802	1,788	14	4		455		455	1,097	1,038	59			
26	Montana	3	9	15	39	39							57	56	1			
27	Nebraska	5	6	113	181	151	30	(1)	(1)	23		23	172	171	1			
28	Nevada	1		11	11	11							18	18				
29	New Hampshire	18	11	180	320	316	4		5	14	2	12	419	373	46			
30	New Jersey	57	185	565	1,070	1,060	10	1	18	156	2	154	1,779	1,664	115	15	15	
31	New Mexico	2		9	9	9							30	30				
32	New York	[2] 70	371	1,103	3,557	3,356	201	134	30	1,380		1,380	5,578	4,915	663	16	13	3
33	North Carolina	9	32	44	95	87	8						196	194	2			
34	North Dakota	4	5	18	23	23							54	51	3			
35	Ohio	50	219	1,392	2,348	2,336	12		21	474		474	2,969	2,761	208			
36	Oregon	2		32	63	63							128	118	10			
37	Pennsylvania	56	387	719	3,238	3,232	6	85	137	4,353	53	4,300	3,566	3,408	158			
38	Rhode Island	6	11	269	296	296		3	12	201		201	609	548	61			
39	South Carolina	3	5	56	66	66							138	138				
40	South Dakota	3		15	15	15							33	31	2			
41	Tennessee	4	3	75	129	129			6	45		45	267	250	17			
42	Texas	10	10	219	283	281	2		7	26		26	522	515	7			
43	Utah	1		16	18	16	2						21	21				
44	Vermont	11	3	78	101	101			2	9	9		231	217	14			
45	Virginia	9	19	117	303	298	5		6	136		136	407	306	101			
46	Washington	7	6	106	166	166		2		2	2		283	282	1			
47	West Virginia	4	5	53	58	58							132	130	2			
48	Wisconsin	26	94	316	698	696	2	36	2	201	84	117	1,220	1,143	77			
49	Wyoming	2	6	2	8	8							10	10		4	4	

[1] Not reported.

[2] New York city has 2 separate systems, but is treated as 1 system.

SYSTEMS, BY STATES: 1902.

Special telephones.	Fire alarms received.	CENTRAL OFFICE EQUIPMENT.											Single circuits.	CENTRAL STATION POWER EQUIPMENT.								
		Transmitters.		Receiving registers, all kinds.	Receiving circuits.	Transmitting circuits.	Telegraph switchboards.			Telephone switchboards.				Engines.		Dynamos.		Motor generators and dynamotors.		Battery cells.		
		Manual.	Automatic.				Number.	Number of sections.	Total capacity.	Number.	Number of sections.	Total capacity.		Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Primary.	Storage.	
1,900	85,070	155	295	452	1,973	1,361	214	259	2,407	62	153	6,480	442	7	58	19	51	81	47	57,010	49,327	1
8	838	......	4	3	17	7	2	2	12	......	......	......	2	......	......	......	......	......	......	176	405	2
1	70	1	......	3	4	2	......	......	......	......	......	......	......	......	......	......	......	......	......	49	......	3
......	305	......	1	11	7	4	1	1	4	......	......	......	......	......	......	......	......	......	......	178	26	4
58	2,661	4	12	19	82	50	15	23	122	4	9	125	17	......	......	1	1	1	1	7,140	2,126	5
6	1,295	......	3	2	16	14	......	......	......	1	1	6	9	......	......	......	......	......	......	376	667	6
33	1,183	3	12	4	52	78	6	7	44	1	1	25	15	......	......	......	......	......	......	1,610	1,597	7
......	80	......	1	1	6	6	......	......	......	......	......	......	......	......	......	......	......	......	......	50	450	8
......	786	1	2	3	30	14	......	......	......	2	3	250	......	......	......	......	......	1	1	......	906	9
6	349	2	1	2	18	10	1	1	4	......	......	......	4	......	......	......	......	......	......	200	312	10
6	1,191	1	3	1	28	20	3	3	26	......	......	......	4	......	......	......	......	......	......	255	956	11
......	50	......	......	......	......	......	......	......	......	......	......	......	1	......	......	......	......	......	......	50	......	12
148	9,027	28	12	42	78	63	8	8	24	5	6	311	22	......	......	......	......	20	7	1,657	1,684	13
3	3,648	3	6	13	71	56	6	10	73	3	6	110	25	......	......	......	......	......	......	2,312	1,043	14
26	1,807	......	8	26	36	33	*4	5	135	......	......	......	10	......	......	......	......	......	......	542	1,133	15
2	512	1	1	1	8	6	1	1	4	......	......	......	5	......	......	......	......	......	......	461	......	16
32	1,864	4	6	6	25	24	1	1	2	1	34	50	5	......	......	......	......	......	......	971	13	17
53	511	1	2	1	22	21	3	3	26	1	1	100	......	......	......	......	......	......	......	125	967	18
......	940	......	6	2	27	14	5	5	48	......	......	......	17	......	......	......	......	2	2	917	1,158	19
30	1,053	31	2	1	31	6	1	1	50	1	7	1,920	2	......	......	......	......	......	......	78	127	20
245	9,491	14	50	71	318	250	33	35	554	5	6	144	50	7	58	9	40	43	14	5,024	11,311	21
108	2,830	8	17	17	64	33	6	6	58	3	3	115	24	......	......	1	2	1	1	1,292	2,505	22
45	2,430	2	3	15	55	26	7	7	64	5	5	116	12	......	......	1	1	......	......	380	2,358	23
......	239	......	2	1	8	1	......	......	......	......	......	......	2	......	......	......	......	......	......	152	90	24
246	2,272	2	1	1	42	20	15	15	185	2	2	150	2	......	......	......	......	1	1	1,371	......	25
......	85	......	1	......	2	......	......	......	......	......	......	......	2	......	......	......	......	......	......	202	......	26
17	585	1	3	1	9	7	2	2	8	1	1	5	2	......	......	......	......	......	......	136	418	27
......	27	......	......	......	......	......	......	......	......	......	......	......	1	......	......	2	1	1	1	......	50	28
......	787	......	7	8	33	19	4	7	25	......	......	......	11	......	......	......	......	1	1	834	571	29
87	3,306	6	15	13	78	72	11	14	88	5	9	196	41	......	......	1	1	2	2	2,706	2,754	30
......	48	......	......	......	......	......	......	......	......	......	......	......	2	......	......	......	......	......	......	72	4	31
254	12,794	11	30	79	261	127	24	44	355	5	6	173	39	......	......	1	3	2	6	10,005	4,411	32
2	434	......	3	......	13	6	1	1	3	......	......	......	6	......	......	......	......	......	......	388	309	33
......	130	......	......	......	......	......	......	......	......	......	......	......	4	......	......	......	......	......	......	195	......	34
130	6,142	8	22	43	156	93	15	15	91	4	4	186	22	......	......	......	......	2	7	5,539	681	35
......	454	1	1	1	8	8	1	1	8	......	......	......	1	......	......	......	......	......	......	45	528	36
133	4,571	7	18	16	140	102	13	14	223	6	28	2,208	39	......	......	......	......	2	1	6,020	3,270	37
46	718	3	4	2	44	30	......	......	......	2	11	30	2	......	......	......	......	......	......	474	1,370	38
......	160	1	2	......	10	4	1	1	8	......	......	......	1	......	......	......	......	......	......	50	369	39
......	91	......	......	......	......	......	......	......	......	......	......	......	3	......	......	......	......	......	......	96	36	40
25	995	......	3	1	20	20	2	2	18	1	1	50	1	......	......	......	......	......	......	554	75	41
2	1,320	4	7	2	36	25	5	5	32	......	......	......	3	......	......	......	......	......	......	646	1,014	42
......	108	......	1	1	3	2	......	......	......	......	......	......	......	......	......	......	......	......	......	230	......	43
......	264	......	3	5	9	6	1	1	3	......	......	......	8	......	......	2	1	......	......	511	114	44
23	1,708	1	4	7	26	20	3	3	37	2	3	60	5	......	......	......	......	......	......	499	1,271	45
53	1,275	1	3	9	18	14	3	4	20	1	5	100	4	......	......	......	......	......	......	253	938	46
......	462	......	......	1	......	......	......	......	......	......	......	......	4	......	......	......	......	......	......	230	30	47
72	3,135	5	13	17	62	48	10	11	53	1	1	50	11	......	......	1	1	2	2	1,884	1,280	48
......	39	......	......	......	......	......	......	......	......	......	......	......	2	......	......	......	......	......	......	75	......	49

As might be expected, the 764 systems, while distributed through 48 states and territories, are to be found chiefly in the older and more densely populated sections. Massachusetts has the largest number, namely, 106; New York is second, with 70 (or 71 if New York city were to be credited with two systems instead of being counted as one); New Jersey is third, with 57; followed by Pennsylvania, with 56; Ohio, 50; Michigan, 40; Indiana, 37; Illinois, 34; California, 28; Connecticut and Wisconsin, each 26; Maine, 22; Iowa, 19; New Hampshire, 18; Minnesota, 17; Colorado and Kentucky, each 12; Vermont, 11; and Texas, 10. New York, however, leads in almost every respect, having 5,578 signaling boxes, as compared with the next state in rank, Massachusetts, which has 4,890. With regard to the use of the telephone as central station equipment, Maryland is reported as having 1,920 drops, or lines, or a shade less than 30 per cent of the total capacity of the country thus engaged, while Pennsylvania has 2,208, or 34 per cent. In telephonic capacity 64 per cent of the total is thus accounted for, but as this represents only 7 switchboards, 1 in Maryland and 6 in Pennsylvania, it can not be accepted as a full indication of the facts, 55 of the boards being in use for such work in 21 of the other states or territories.

The total number of signaling and annunciating boxes in the United States was 37,832, from which 85,070 alarms were received. Of these alarms 12,794 are credited to New York, from 5,594 boxes, or 2 per box, per annum, whereas in the state of Illinois, with 2,278 boxes, the number of alarms received was 9,027, or 4 per box. In Massachusetts, with 4,890 boxes, 9,491 alarms were received, or 2 per box. In the state of Pennsylvania, with 3,566 boxes, 4,571 alarms were reported as having been received, or about 1.3 per box. In Kentucky, with 603 boxes, 1,864 alarms were reported, or 3 per box. In Minnesota, with 838 boxes, 2,430 fire alarms were reported, or 3 per box. The variations in the average number of fire alarms per box may be due either to the prevalence of wooden construction in buildings, resulting in more frequent fire alarms, or to the heavy duties thrown on the boxes by distributing them more sparsely. This latter supposition, however, does not appear to be borne out upon examining the distribution of boxes per mile of wire. For example, Illinois, with a total of 2,820 miles of wire, had 2,278 boxes, or less than 1 box per mile of wire, while Pennsylvania, with 7,591 miles of wire, had only 3,566 boxes, or less than 1 box to 2 miles of wire. Minnesota had 838 boxes to 1,084 miles of wire, or about the same proportion as Massachusetts, with 5,330 miles of wire and 4,890 boxes. New York appears to be well equipped in this respect, having 5,594 boxes to 4,937 miles of wire, thus giving more than 1 box to the mile. The higher proportion of boxes per mile of wire in New York may doubtless be explained by the liberal distribution in the densely populated districts of New York city and Brooklyn, but the difference between the figures for New York and Pennsylvania is, to say the least, quite striking. The proportion of alarms per box would indicate that Pennsylvania is as well served with its fire boxes as New York is with its larger number, but that Illinois falls below the standard of these two great Eastern states.

The suggestion that the number of alarms per box may have some relation to the use of wood in construction is supported by statistics from the Southern states, where the use of brick and stone is less prevalent than in the North. Tennessee, with 267 boxes, reported 995 alarms, or nearly 4 per box; Georgia, 412 boxes and 1,191 alarms, or nearly 3 per box; Virginia, 407 boxes and 1,708 alarms, or over 4 per box. In New York, and other closely settled cities in the Northern states, the use of wood for walls and roofs has long been prohibited within the urban areas, and the general introduction of structural steel in buildings has been a notable feature of the last decade.

Table 8 is of interest as presenting the figures for the electric fire alarm and police patrol systems of Honolulu, Hawaii.

TABLE 8.—*Electric fire alarm and police patrol systems of Honolulu, Hawaii: 1902.*

Date of establishment	1901
Overhead construction:	
Miles of pole line, owned	50
Total wire mileage, single wire	100
Number and character of boxes or signaling stations:	
Signaling, on poles or posts	50
Telephoning, on poles or posts	50
Special telephones	5
Fire alarms received	50
Police calls received or sent	2,750
Telephone	150
All other	2,600
Central office equipment:	
Automatic transmitters	4
Receiving registers, all kinds	1
Receiving circuits	4
Transmitting circuits	4
Telephone switchboards, number	1
Number of sections	1
Total capacity	150
Central station power equipment:	
Storage battery cells	290

The construction shown in Table 8 was used interchangeably for fire alarm and police patrol purposes. All the construction is overhead, embracing 50 miles of pole line owned by the department, with 100 miles of circuit, and 50 signaling and 50 telephone boxes on poles or posts, supplemented by 5 special telephones. The central office equipment includes 4 automatic transmitters and 1 receiving register, 4 receiving and 4 transmitting circuits, and 1 telephone switchboard with a capacity of 150 drops, and the power equipment embraces 290 storage battery cells for supplying current to the whole system. During the year ending December 31, 1902, 50 fire alarms were received, averaging 1 per signaling box, and 2,750 police calls were received or sent, of which 150 were telephonic. It is of interest to note that one of our outlying dependencies should be so well equipped, boasting of facilities which, in fact, a great many communities of importance within continental United States do not enjoy. The apparatus and methods, and probably the supplies, in use in Honolulu are, however, of American origin.

In a great many cities of the United States it is the custom of the municipal authorities to exact, by ordinance, by grant of franchise, or otherwise, the right to string wires on a certain number of cross-arm pins on the pole line of a telegraph, telephone, electric light, street railway, or other electric company, or to reserve the right to use a certain number of ducts in an underground wiring system belonging to a specific conduit company, or to any company operating some specified public service.

Table 9 gives the number of fire alarm and police patrol systems, grouped according to the population of the respective cities, which have reserved the right of way on poles or in conduits without cost to the city.

TABLE 9.—*Electric fire alarm and police patrol systems having perpetual right of way on poles or in conduits, without cost to the city, grouped according to population of cities: 1902.*

POPULATION GROUPS.	Fire alarm.	Police patrol.
Total	623	123
100,000 and over	34	30
50,000 and under 100,000	36	26
25,000 and under 50,000	73	31
10,000 and under 25,000	195	26
Under 10,000	285	10

According to Table 9, perpetual rights of way of this character have been reserved for 623 fire alarm and 123 police patrol systems. It is interesting to note that of the fire alarm systems, which secured rights and accommodations of this character without cost as an offset to the grants made to private companies, 480 belonged to communities of less than 25,000 population.

Table 10 may be regarded as a connecting link between the fire alarm and police patrol statistics embraced in this report, as it includes the systems, or portions of systems, which are employed interchangeably for fire alarm and police patrol purposes, grouped according to the population of cities. The statistics given in this table are included in the tables giving the data for fire alarm and police patrol systems, respectively.

TABLE 10.—*Construction and equipment of electric systems used interchangeably for fire alarm and police patrol, grouped according to population of cities: 1902.*

	POPULATION GROUPS.					
	Total.	100,000 and over.	50,000 and under 100,000.	25,000 and under 50,000.	10,000 and under 25,000.	Under 10,000.
Number of systems	23	6	4	5	2	6
Overhead construction:						
Miles of pole line—						
Owned	454	385	23	37	......	9
Leased	485	140	153	87	23	82
Wire mileage—						
Total	5,533	4,809	470	132	23	99
Single wire	5,488	4,770	465	131	23	99
Single wire in cables	45	39	5	1	......	......
Underground construction:						
Street miles of conduit—						
Owned	99	97	2	......	......	......
Leased	157	156	1	......	......	......
Wire mileage—						
Total	5,742	5,737	5	......	......	......
Single wire	70	68	2	......	......	......
Single wire in cables	5,672	5,669	3	......	......	......
Signaling boxes or stations	1,711	1,107	270	79	72	183
Number on poles or posts	1,472	961	222	69	72	148
All other	239	146	48	10	......	35
Special telephones	369	296	65	6	......	2
Central office equipment:						
Manual transmitters	12	7	3	1	......	1
Automatic transmitters	12	5	3	2	......	2
Receiving registers, all kinds	57	28	12	14	......	3
Receiving circuits	197	146	25	21	......	5
Transmitting circuits	121	63	37	17	......	4
Telegraph switchboards, number	34	31	1	1	......	1
Number of sections	39	35	1	1	......	2
Total capacity	354	328	12	10	......	4
Telephone switchboards, number	11	8	2	1	......	......
Number of sections	17	9	6	2	......	......
Total capacity	761	640	113	8	......	......
Single circuits	6	......	......	......	2	4
Central station power equipment:						
Motor generators and dynamotors, number	10	2	7	1	......	......
Total horsepower	5	2	2	1	......	......
Battery cells—						
Primary	7,748	6,709	446	200	146	247
Storage	4,227	1,631	1,690	832	......	74

Table 10 embraces 23 systems, with 5,533 miles of overhead wire and 5,742 miles of wire in conduit, upon which were distributed 1,711 signaling boxes or stations, of which 1,472 were on poles or posts; these boxes were supplemented by 369 special telephones. The central office equipment of these systems included 12 manual transmitters, 12 automatic transmitters, 57 receiving registers, 197 receiving circuits, and 121 transmitting circuits. There were also 34 telegraph switchboards, with a capacity of 354 circuits, and 11 telephone switchboards, with a total capacity of 761 drops, or lines. Among these systems there were 6 single circuits, all of which were in communities of less than 25,000 population. The power equipment of the central offices embraced 7,748 cells of primary battery, 4,227 cells of storage battery, and 10 motor generators and dynamotors, with a total capacity of 5 horsepower.

These 23 combination systems were widely distributed as to the population of cities, 6 systems being in cities of 100,000 and over, 4 in cities of 50,000 and under 100,000, 5 in cities of 25,000 and under 50,000, 2 in cities of 10,000 and under 25,000, and 6 in cities and towns of less than 10,000. Cities of 50,000 population and over reported all of the underground construction of these systems and the great bulk of the apparatus, although it should be noted that the 6 plants in cities of less than 10,000 population had more than 30 boxes per system. It might be expected that the combination of the fire alarm and police patrol systems would have found favor in the small communities for reasons of economy, but this table does not support such an inference.

HISTORICAL AND DESCRIPTIVE.

The electric telegraph was not utilized for fire alarm purposes until the beginning of the second half of the nineteenth century. Even to-day there are a great many communities in America which retain the inadequate method of notifying the community by ringing a bell in some high tower, or by blowing a steam whistle, the number of strokes or pauses indicating roughly the location of the fire. As late as 1865, New York city had a watchtower system, under which a watchman, on discovering a fire or receiving an alarm, sounded upon his bell the number of the district; this was repeated by watchtowers all over the city, and thus the whole community was warned. While such a method was effective in distributing information, it is obvious that there was abundant opportunity for delay and mistakes; moreover, while the alarm served as an immediate call to duty, it also notified a large number of people who had no immediate concern in the matter.

It was inevitable that the introduction of the electromagnetic telegraph by Prof. S. F. B. Morse should direct attention to the ease with which warning signals could be instantaneously transmitted from point to point. The first suggestion for the use of the telegraph for fire alarm purposes is said to have been made by Dr. W. F. Channing, of Boston, as early as 1839, when the telegraph itself was in a very crude and imperfect condition. Making a suggestion, however, is one thing, and constructing a practical device is quite another. The history of electricity is full of instances where possibilities were suggested years before it was found feasible to devise the proper apparatus. It is an authentic fact, however, that in 1845 Doctor Channing published in the Boston Advertiser an article in which he described a method of applying the telegraph to fire alarms. The plan was as follows:

A central office was to be established in some public building, in which the necessary battery, together with a Morse register and an alarm bell, should be located; a double wire to proceed from thence over the housetops successively to every engine house and fire bell in the city, and return again to complete its circuit to the place from whence it started. In every station thus established a Morse register in connection with an alarm bell was to be placed, also a key, by the simple depression of which an appropriate signal would be instantly conveyed to every other station on the circuit.

He also suggested the modification of having five or six circuits, or even a circuit from every station, to the central office. By this method the operator would be able to communicate directly to all the stations, and, if so desired, every alarm of fire might be made to pass through the central office before being communicated to the different stations. From among the many modifications to which his design is susceptible, Doctor Channing calls special attention to one, in these words: "There is, however, one which deserves to be specially mentioned. By a slight change of the arrangement of the alarm bell stations and increase of machinery, the hammers of the bells could all be disposed so as to strike mechanically on the communication of a galvanic impulse from the central office. The agent (operator) would therefore be enabled, by depressing a single key with his finger at certain intervals, to ring out an alarm defining the position of the fire simultaneously on every church bell in the city." This description clearly indicates the electro-mechanical bell striker, urges the municipal authorities to take his project into consideration; and, as the city had been behindhand in the matter of giving alarms of fire, the adoption of this system would place her in advance of other cities.[1]

Nothing, however, was done until early in the winter of 1847–48, when L. L. Sadler, superintendent of the Boston and New York telegraph line, in discussing with F. O. J. Smith, one of the pioneer capitalists associated with Morse, and then president of the Portland telegraph line, the feasibility of using telegraphy for fire alarm purposes, stated that he had in his employ at Framingham, Mass., an operator named Moses G. Farmer, who was the most ingenious man he had ever seen, and who, he believed, could work out a system. The matter was brought to young Farmer's notice, and within a week he had produced an apparatus capable of carrying out the idea, based on electro-magnets and the striking mechanism of an old church clock. This was the first machine ever constructed for giving an electric fire alarm, and served as the starting point for all the later work that has been done in this field. Nothing more came of it at the time, however, although the apparatus was indorsed by Mayor Quincy, of Boston.

In 1851 Doctor Channing succeeded in interesting the Boston city council in the subject of fire alarm telegraphs to such an extent that $10,000 was appropriated for an experiment. His plan again proposed numerous box stations, connected by telegraph circuits with the central office, from which all alarm signals received from the boxes were to be sent out over other circuits to the bell towers, so that the box signals would be simultaneously struck, electrically, by every fire alarm bell in the city. At a total cost of about $16,000 this system, with some modifications, was adopted for 39 signal stations.

It is possible that both Doctor Channing and Professor Farmer worked out their ideas independently, although attention should be called to the fact that

[1] Adam Bosch, Trans. Am. Inst. Elec. Engrs., Vol. XIV, 1897, page 336.

Charles Robertson, who introduced the Morse telegraph system into Germany, had utilized it in New York city in 1850 to aid the fire department in signaling the existence of fires. In fact, lacking evidence to the contrary, it would appear that the authorities in New York city were pioneers in this direction. As early as November, 1846, the common council of the city authorized the introduction of the Morse magnetic telegraph into the fire service, and in the next month at a meeting of engineers and firemen, a committee of five was appointed to urge the adoption of the plans recommended by the chief engineer relative to such work. In 1847 a permit was granted to Hugh Downing and Royal E. House, a well-known telegraph inventor, to set up a line of telegraph for fire purposes in different parts of the city, at a cost of $500. In 1851 the connection of the bell towers with fire headquarters by telegraph was completed with immediate beneficial results, but it is a matter of official record that public curiosity on the subject was so great that the entire telegraph apparatus was often put out of service by the tampering fingers of innocent visitors. Nothing permanent, however, came of such experimental work, and, for the evolution of the practical machinery required, attention must be paid to the joint efforts of Doctor Channing and Professor Farmer. In 1851 Professor Farmer became superintendent of the Boston fire alarm system, continuing in active service until 1855, and remaining for another four years with the department which his skill and ingenuity had done so much to create. During this period Doctor Channing and Professor Farmer took out, singly and together, several patents which became the foundation of the fire alarm system as it exists today. One of these patents, covering what was known as the "village system," was taken out by Professor Farmer in 1859.

It naturally would be supposed that so invaluable an aid in subduing fires would receive the warmest welcome from those engaged in fire extinction; but it is a fact that the bitterest enemies of the new system were found among the firemen themselves. The fire departments, about the middle of the last century, were volunteer organizations, often partaking of the character of a club, and frequently engaged deeply in politics. The introduction of prompt and efficient methods of giving the alarm marked the beginning of a new era and the creation of the paid fire alarm departments.

The advent in the field of the late John N. Gamewell marked another point of departure in the art and industry. In regard to his work, J. W. Stover has said:

> The fire alarm telegraph as it stands to-day is not the work of one nor a half dozen men. Many have contributed to its perfection. I have only named a few. It has been an evolution; but if I were asked to name the one man to whom, more than all others, we are indebted for its progress and general use, I should without hesitation name John N. Gamewell, of South Carolina. From 1855 to the time of his death he devoted his splendid business ability and his best efforts for its advancement and its extended use. It has been a number of times suggested to me that those who best understand the importance of his work should erect a monument to his memory. My answer has been, and is, It is not necessary; the evidence of his devotion and beneficent work may be found on nearly every street of nearly every city and town in this broad land.[1]

Hearing or reading a lecture by Doctor Channing on the subject of fire alarm telegraphs, delivered in the Smithsonian Institution at Washington in 1855, Mr. Gamewell at once became deeply interested in the subject, and bought from Messrs. Channing and Farmer the right to the use of their inventions and patents in the Southern states. In 1859 he purchased the rights for the rest of the country. This investment, while small compared with what is expended upon fire alarm telegraphs at the present time, was an evidence of great courage and enterprise in those days. The original plant in Boston, installed in 1852, comprised only 19 tower bell strikers and 26 street signal stations, and during the year 1854—two years after the system had been introduced—the number of fire alarms in Boston was only 195. The Boston system, with some improvements, was taken up in Philadelphia in 1855, and St. Louis closed a contract in 1856, though this plant was not in use until early in 1858. The cities of New Orleans and Baltimore adopted the system in 1860, but further development was seriously arrested by the outbreak of the Civil War.

No sooner was the war over than Mr. Gamewell again took up the work actively, pushing the system with great vigor and perseverance by means of a corporation to which he gave his name. But it was not until 1869 that New York city, which had organized a paid department in 1865, abandoned its old watchmen and bell towers in favor of the modern methods with which this report deals. Since that time the progress of the system has been rapid, and several ingenious inventors have devoted their energies to the subject. The leading systems are those known broadly as the Gamewell, the Gaynor, and the Speicher.[2]

The apparatus has of course been greatly improved since its introduction. For example, the first signal boxes used in Boston depended for their operation upon the turning by hand of a crank similar to the one so long a familiar feature of telephone stations for ringing up "central." The original instructions placed on these signal boxes were that the person sending in the alarm should turn the crank six times. Fastened directly to the shaft of this crank was the break-circuit wheel; one-half of this wheel was so toothed that in revolving it transmitted and recorded in dots or dashes, by means of a Morse register at the central fire headquarters, the number of the fire district in which the

[1] "Progress in Fire Alarm Telegraphy;" paper read before International Association of Fire Engineers, New York city, September, 1902.

[2] For details see Maver's "American Telegraphy and Encyclopedia of the Telegraph."

fire was located, while the other half transmitted a certain number of current pulsations, indicating on the Morse register the number of the box. The tower bell was still used, but only to sound the district; in order to ascertain the exact location of a fire, the firemen were supposed to go to the street boxes and count the taps or strokes made on the small bells inside, these signal taps being sent from the central office as soon as the alarm had been transmitted to the tower bells. If a fireman on reaching such a box did not find the bell striking, it was his duty to signal the central office at once, whereupon the operator there would repeat the signal, unless the circuit had been broken or interrupted. All this was excellent in theory, but it was quickly demonstrated that people sending in alarms would exercise the crank so vigorously, in the excitement of the moment, that the operator at the central office could not decipher the signals. The instructions upon the boxes were then made to read to the effect that the crank should be turned twenty-five times, which would seem to give abundant opportunity for sending in the signal clearly, but even then there were mistakes and delays. With regard to Boston, Adam Bosch says:

> The original crank signal boxes remained in service in Boston until 1866, in which year automatic boxes were substituted in their place. The following year, Joseph B. Stearns, the immediate successor of Farmer in the superintendency of the Boston fire alarm telegraph, received a patent for an apparatus operated by "reverse currents," which permitted the simultaneous use of the same wire for receiving a signal from a box and transmitting it to the alarm bells. Several years prior to the introduction of automatic signal boxes, Stearns abandoned the method of striking the district numbers on the bells, and new boxes were designed to strike the box numbers only. While, with the adoption of the automatic signal box, the speed with which a fire alarm box was operated no longer depended on the temperament or mental condition of the person giving the signal, a proof was soon furnished that in a matter of this kind as little as possible should be left to "the intelligence of the public." Incorrect signals were often received from these boxes, for the occurrence of which no cause could be assigned. It was usually the first "round" that was found to be wrong. This remained a puzzle until the cause was discovered, which was this—that the person giving the alarm, disregarding the instructions to "pull the hook down once and let go," would, after the first pull, by way of emphasis, give the hook another pull or two. This would momentarily suspend the movement of the break wheel, and if it occurred between two successive breaks a long pause would ensue, and the signal would be either unintelligible or a number entirely different from the box number would be transmitted.

One of the first important steps forward, therefore, was found in the automatic signal box, operated by pulling the hook trigger and then releasing the mechanism. The patent on this device was taken out in 1867 by Charles T. Chester, of New York, while further improvements were made and patented about two years later by Crane and Rogers, of Boston, who introduced what was called the "noninterference pull." The use of this prevented interference with a signal sent in by a box until its completion; hence each box was enabled to transmit its signal free from the mistakes and delays caused either by careless and excited persons or by those governed by malicious intent.

In 1871 Mr. Gamewell, who was the first to use an open-circuit break wheel, secured the first patent on his noninterfering signal box; this prevented interference or confusion between alarms sent in from different boxes at the same time, thus securing certainty of transmission. The new Gamewell box was a normally wound box with trigger pulls and a so-called skeleton break wheel. All automatic boxes were actuated either by weights or by springs; if the latter, they were pull wound. The Gamewell box contained an electromagnet and an armature which, when in the position farthest from the magnet, shunted the break wheel. If a box was pulled while the armature was in its normal position against the magnet, the armature was held there until the signal was completed. By the same mechanism the armature in every other box on the same circuit was held in position to shunt the break wheel, so that, even if another box were pulled, interference with the first signal would be impossible. The only chance of interference lay in the possibility that the hook of the second box might be pulled the instant the circuit was closed, and while the armature was still held close to the magnet; but the use of a skeleton break wheel made these periods of contact so exceedingly short that the chances of interference were very remote.

The next step forward in this important direction was taken by J. M. Gardner, of Hackensack, N. J., who in 1880 patented a box[1] which provided not only against the dispatch and reception of confused alarms due to the use of imperfect pull devices at the signal box, but also against interference with a signal from any box through the "cutting in" of another box on the same circuit; in this way both "local" and "distance" noninterference were secured. The benefits of this improvement were felt in the more rapid detection and extinction of fires.

Another important improvement in signal boxes was introduced by Mr. Tooker, of Chicago, in 1875. Hitherto delays had often occurred in transmitting alarms because the key to open a box could not be found on the instant. The Tooker keyless door was intended to deter malicious persons from sending in false alarms or otherwise interfering with the apparatus. The door was opened by the turning of a handle, which wound up a spring, thus setting in motion the mechanism by which a local alarm was sounded on a small gong within the box. The person using the Tooker device, having turned the handle of the door and heard the local alarm, often thought he had done all that was necessary, and would walk away without pulling the hook that sent in the signal to "central," so that the vital part of the signal was omitted. The next step in the development of this idea was the invention made by M. H. Suren in

[1] See Maver's "American Telegraphy and Encyclopedia of the Telegraph" for technical details.

1895. In the operation of this invention it was only necessary that the handle of the door should be turned, whereupon the bell rang and the alarm was transmitted to the central office without even opening the door of the box. A similar development is seen in the device patented by J. J. Ruddick in 1889, by means of which the boxes, besides being noninterfering, are made to succeed each other, each in turn sending in its own definite signal, even if three or four boxes on the same circuit are pulled at the same time.

It is a common practice to call attention to the signal boxes and poles by painting them a bright red color, or in some other way equally distinctive, so as to enable a person desiring to use a box to find it immediately. In many communities lists of signal boxes are printed and distributed, so as to familiarize the public with their location.

Reference has already been made to the fact that as early as 1859 Professor Farmer took out a patent on the "village system." A crude system of this kind was installed in Mobile, Ala., in 1866. It is obvious, however, that in view of the cost of maintaining a staff solely for the fire alarm service, towns and villages of small size could not enjoy this means of protection unless the human element had in a large measure been eliminated. In 1870 the village system was rendered feasible of application by Edwin Rogers, of Boston, who patented what is known as the "automatic repeater." This device made it practicable to strike all the bells and gongs of a fire alarm system directly from one street signal box without the intervention of an operator at the central office. The idea was too valuable, however, to remain restricted in its application to only small cities, and the principle was rendered useful in central office systems by the application of what is known as the "joker," invented in 1876 by Prof. J. P. Barrett, superintendent of the bureau of electricity of the city of Chicago, and head of the electrical department of the Columbian World's Fair in 1893. By means of the "joker" alarms can be sent directly from a signal box to the fire companies whose duty it is to respond first. This, in combination with the automatic repeater, has been found invaluable in modern work.

In the fire engine house, to which signals from central are transmitted, is usually found the electro-mechanical indicator, which dates back to 1875. This is placed in a conspicuous position, and shows at once, in large figures, the number of every box from which an alarm is being transmitted; in this manner each alarm is brought to notice, and the location of the fire indicated. The gongs in engine houses, rung by the direct agency of electro-magnets which attract and then release an armature, are another familiar feature; many of them are from 6 to 24 inches in diameter. Other important accessories in such work are the whistle, which is often sounded in small communities, and particularly the tower bell, which remains a distinct element of fire alarm work. In some instances these bells have reached remarkable proportions, one type striking 10,000 blows of a most sonorous character, with a weight drop of 25 feet. An ingenious feature in connection with this bell is its attachment to an electric motor which automatically starts to rewind the mechanism when the weight has run down; and this automatic winding system can be used also to wind up the weights driving the transmitters and multiple registers at the central fire headquarters.

The switchboards are, of course, the most conspicuous feature of the central fire office; they are usually handsome and substantially built of mahogany or walnut in the form of a hollow square, so that the operators have all the apparatus and mechanism within easy reach. In the fire alarm circuits are inserted galvanometers, whose readings can be taken at the board, to show that the batteries are up to the electro-motive force required for signal transmission, and also to indicate the electrical condition of the circuits themselves, giving notice of any break or grounding. In fact, the circuits are under constant test, as it is obvious that nontransmission of a signal might be attended with disastrous and even fatal results. The central office apparatus includes a relay in each circuit from the signal boxes; for each relay there is a multiple pen or registering device for the purpose of permanently recording the alarms received, and an annunciator so placed that the opening of the circuit causes the electro-magnetic drop to fall, disclosing the number of the circuit affected.

A notable feature of every well organized central fire alarm telegraph office is the repeater, under a glass case in the center of the operating room. This repeater is usually provided with a locking mechanism, by means of which all the armatures of the relays of fire signal box circuits, except that on which the alarm has come in, are locked, so that they can not respond to any new alarm that may be sent in during the transmission of the first alarm; thus confused signals are avoided. There are other devices also employed as adjuncts of this work, such as voltmeters, ammeters, and other apparatus for electrical measurements, etc.

The battery itself was at first of the expensive Grove and Daniells type, but for a great many years past it has been of the type of primary cell known as the gravity, or sulphate of copper—a form quite suitable for fire alarm telegraph requirements, being easily supplied with new material, readily cleaned, and simple enough in construction to be maintained by any fireman of ordinary intelligence.

Within the last decade, however, the storage battery has been adopted for this class of work to a considerable extent, being found in many of the larger cities. The maintenance cost of the storage battery equipment is said to be only half that of a primary battery plant of equal size; but since the battery equipment is hardly large enough, as a general thing, to warrant the expense of an independent or isolated power plant, the practice is generally to connect the batteries with the local central power station, from which the needed supply of charging current is ordinarily obtained. It is obvious, however, that even this source of supply can not always be depended upon, although the batteries carry a considerable reserve supply; hence some of the central fire alarm stations maintain more than one source of current supply, or connect with a source by more than one circuit.

A further development of recent years has been the more general use of the telephone for fire alarm service. This arose in a natural and simple manner from the fact that telephone subscribers in many small towns would call "central" to ask where the fire was. It was readily seen that "central" could be employed very usefully, either as an auxiliary in the transmission of fire alarms or as a fairly efficient substitute for the regular alarm. For example, at Kansas City, Mo., the local telephone service discharges all the functions of a fire alarm system; the police patrol system there has, however, a signal telegraph.

Another very interesting feature of the more recent developments, which, however, is not considered in the statistical portion of this report because it does not constitute an integral part of the municipal fire alarm telegraph, is what is known as the auxiliary system. The auxiliary boxes are placed in convenient locations in buildings, in a school, for example, at the teacher's desk; in case of fire, a small glass pane in the front of the box is broken, and a ring pulled down, which action operates a trip in the nearest street box and causes the alarm to be sent to fire headquarters exactly as though the box had been pulled by hand. The auxiliary circuit has a special battery, and is not connected electrically with the regular circuits of the fire alarm system.

As a general thing the municipal fire alarm systems, like telephone companies, have resisted the attachment of any auxiliary apparatus to the devices with which communication is maintained, on the ground that needless additional complication was brought about, thus lowering the efficiency of the system. The auxiliary fire alarm telegraph, however, is so valuable an aid to the fire department that its use has been encouraged. By the use of this system, not only can an alarm be transmitted at once to the fire department, no matter how remote the nearest street box may be, but persons all over the building can be notified immediately and the chance of panic is thus minimized. In New York city, at the beginning of 1902, no fewer than 2,400 of these boxes had been installed, with the approval of the New York Board of Fire Underwriters. The only serious objection to such work has been the leaving of the auxiliary devices in the hands of a private or individual commercial company, instead of constituting it part of the municipal department under control of the city authorities.

Another kind of fire alarm telegraph, somewhat automatic in character, is that known as "thermostatic." In this the materials or mechanism of the thermostats, when heated to a given degree of temperature, close the circuit, thus sending in an alarm, and in some cases also releasing showers of water from pipes so placed that a fire may be put out, even before outside assistance arrives. Of course, there is always the chance that such a device may go off accidentally, through some rise of temperature not due to an outbreak of a fire, or through some accident to the mechanism, in which event, if water is released, considerable damage may be done to perishable goods. A quite ingenious extension of the thermostatic principle has been made in the use of a cable in which a soft metal fuse wire is interwoven with the copper wires which constitute the alarm circuits; the generation of undue heat melts immediately the fuse wire in the cable, thus closing the circuit and sending in an alarm. This is a portable and variable arrangement, which can be modified to meet changing circumstances, as, within a storage warehouse or a large department store, the cable may be trailed or drawn at will over any pile of goods to any point where a fire might possibly break out. In Boston some 500 buildings are equipped with automatic fire alarms, and no fewer than 110 with the sprinkler equipment.

Another important part of fire protection work in the leading cities, which should be noted in this connection, is the insurance patrols, maintained by the fire insurance companies themselves. This work consists chiefly in spreading rubber covers over valuable goods at the moment when the risk of loss of such perishable materials is greatest. Perhaps one of the best examples of this is the Boston protective department, maintained by the insurance companies doing business in that city. It has a staff of no fewer than sixty men, specially trained for the work of protecting property exposed to fire and water damage. They operate with six special wagons, supplied with rubber covers, duplicate sprinkler heads, gas fittings, extinguishers, and emergency tools of various kinds, and are in constant readiness to respond to an alarm of fire, just as is the regular fire engine or hose reel. The staff and the wagons are concentrated at three houses, located in sections of the city where the greatest values of property are massed.

Fire alarm pole lines are usually constructed with more than ordinary care, although the wires are sometimes strung upon the poles of the local electric light, telegraph, and telephone companies, and even on those of the trolley systems. Metallic circuits are always used; that is, there is a complete circuit by wire from the box to central and from central back to the box, and also between all other points of communication, the earth being used as part of the circuit only in case of an accident. It is considered good practice to secure the wires to poles at a height of not less than 20 feet from the ground, and to use the finest quality of galvanized-iron wire or hard-drawn copper wire; the wire generally employed has a weight of about 325 pounds to the mile for iron and 170 pounds for copper. All the joints are carefully soldered, and the terminal connections of both iron and copper wires are made with insulated copper wire run through the buildings and up to the apparatus, conduits being often employed for this interior work.

When underground cables are used for fire alarm purposes the ends of the cables are brought out at short intervals to small switchboards usually placed on lampposts, following the method proposed by William Maver, jr., at one time expert on the electrical subways in New York city. In this manner easy access is afforded to the circuits for testing purposes.

In view of the vitally important nature of fire alarm telegraphs, it is rather surprising that more work has not been done in placing the wires underground—not merely out of the way, but where they would be less exposed to the elements or the risk of malicious breakage; no winter goes by and no high wind passes without the breaking of some aerial telegraph circuits.

A scheme for the use of wireless telegraphy in fire alarm signaling apparatus has been suggested by Signor Mollo, chief of the fire department of Naples, Italy, and others. M. Emile Guarini has worked out a plan for the equipment of fire engine houses and numerous buildings at Brussels, Belgium, but at the time of this report it is not known whether the system has been put in operation.

The idea is to utilize thermostats for alarm purposes. The rising of a column of mercury, closing the circuit, energizes an electro-magnet, which, in turn, attracts an armature and releases a disk revolving by means of a spring motor. Each disk has notches cut on its periphery at such distances that they represent arbitrarily, in a code, the number and location of the building. When the disk revolves, its periphery projections make and break a primary circuit, setting up alternating current in the secondary coil, which, in turn, energizes an oscillator system, sending out into space the waves which represent the message. These waves are received upon a long aerial wire raised vertically at the fire engine house and are again converted into oscillations in the resonator circuit, so that the coherer is affected in the usual way, the filings in the coherer being made to close the circuit as the waves come in, and being decohered by the tapper in the relay circuit; the message thus received is recorded on the tape of the register for the local circuit. This system embodies some of the important features of the village and automatic systems already described. At the same time, as a wireless system can not detect the source of a signal, serious difficulties would appear to stand in the way, and the opportunities for malicious interference might be greatly increased, unless some means could be devised to protect the receiving apparatus at the engine house against receiving wireless signals originating elsewhere than at the scene of a fire.

ELECTRIC POLICE PATROL SYSTEMS.

Reports were received from 148 electric police patrol systems. The data for systems used interchangeably for the fire alarm and police patrol services have already been referred to in connection with the statistics for fire alarm systems. The service is of much more recent date than that of the fire alarm, and does not, therefore, include so many plants.

Table 11 shows the boards or departments of administration to which the several police patrol systems are subject.

TABLE 11.—*Electric police patrol systems, grouped according to boards or departments of administration: 1902.*

BOARDS OR DEPARTMENTS OF ADMINISTRATION.	Systems.
Total	148
Administrative bodies	49
Board of police commissioners (or commissioner)	27
Board of police and fire commissioners	6
Board of public safety (or director, or commissioner of)	14
Board of public works (or commissioner of)	4
Board of trustees	1
Department of electricity (or city electrician)	7
Department of fire and police patrol telegraphs	2
Department of police and city property	1
Department of wire inspection	1
Fire commissioner and city council	1
Mayor	1
Mayor and board of police commissioners	1
Mayor and chief of police	1
Mayor and city council	3
Mayor and city marshal	1
Police department (or police)	24
Special committee by vote of town	1
Superintendent of police and board of public safety	1
Not reported	2

From Table 11 it will be seen that 49 systems, or about one-third of the total number reported in 1902, were governed by administrative bodies—boards of aldermen, boards of selectmen, city councils, etc.—27 by boards of police commissioners, 24 by police departments, and 14 by boards of public safety.

As already noted, electric fire alarm systems were installed and operated as early as 1852, and during the decade from 1862 to 1872 no fewer than 40 systems were put into operation. However, with regard to police patrol systems, work in this field was of a very uncertain and indifferent character up to the year 1881.

Table 12 shows the number of police patrol systems installed during each year from 1867 to 1902, inclusive:

TABLE 12.—*Electric police patrol systems installed each year.*

YEAR.	Number.	YEAR.	Number.
Total	148	1885	3
		1884	6
1902	8	1883	3
1901	6	1882	1
1900	8	1881	1
1899	7	1880	1
1898	8	1879	1
1897	5	1878	1
1896	8	1877	
1895	7	1876	1
1894	9	1875	
1893	11	1874	1
1892	7	1873	
1891	10	1872	
1890	13	1871	
1889	4	1870	1
1888	3	1869	
1887	6	1868	
1886	7	1867	1

It will be seen from the above table that only 8 systems had been installed prior to 1882. From that year onward, however, a marked increase was seen. The decade 1882 to 1892 witnessed the installation of 56 plants; the decade 1892 to 1902 was even more active, 76 plants being installed during the period, while during the eleven years from 1892 to 1902, inclusive, there were in all 84 installations. It will be observed, however, that the increase in the introduction of electric police patrol systems has hardly kept pace with the adoption of fire alarm systems, the number of fire alarm systems being in 1902 more than five times as great as the number of police patrol systems, in spite of the fact that the two can be and are so frequently operated in cooperation, or under the same management.

Table 13 presents the general statistics with regard to the construction and equipment of the service and the amount of work done, together with the percentage which each item is of the total:

TABLE 13.—ELECTRIC POLICE PATROL SYSTEMS, GROUPED ACCORDING TO POPULATION OF CITIES, AND PERCENTAGE EACH ITEM IS OF TOTAL: 1902.

	POPULATION GROUPS.						PER CENT OF TOTAL.				
	Total.	100,000 and over.	50,000 and under 100,000.	25,000 and under 50,000.	10,000 and under 25,000.	Under 10,000.	100,000 and over.	50,000 and under 100,000.	25,000 and under 50,000.	10,000 and under 25,000.	Under 10,000.
Number of systems	148	34	30	39	33	12	23.0	20.3	26.3	22.3	8.1
Overhead construction:											
Miles of pole line—											
Owned	829	582	101	95	42	9	70.2	12.2	11.4	5.1	1.1
Leased	3,187	1,589	537	613	302	146	49.9	16.8	19.2	9.5	4.6
Wire mileage—											
Total	17,339	13,552	1,828	1,197	578	184	78.2	10.5	6.9	3.3	1.1
Single wire	14,296	10,654	1,767	1,149	542	184	74.5	12.4	8.0	3.8	1.3
Single wire in cables	3,043	2,898	61	48	36	....	95.2	2.0	1.6	1.2	....
Underground construction:											
Street miles of conduit—											
Owned	271	239	19	1	12	....	88.2	7.0	0.4	4.4	....
Leased	502	425	31	18	28	....	84.6	6.2	3.6	5.6	....
Wire mileage—											
Total	9,011	8,646	178	69	118	....	95.9	2.0	0.8	1.3	....
Single wire	264	172	58	6	28	....	65.1	22.0	2.3	10.6	....
Single wire in cables	8,747	8,474	120	63	90	....	96.9	1.4	0.7	1.0	....
Number and character of boxes or signaling stations:											
Signaling	9,476	6,496	1,330	873	497	280	68.6	14.0	9.2	5.2	3.0
Number on poles or posts	6,747	4,217	1,127	772	399	232	62.5	16.7	11.5	5.9	3.4
All other	2,729	2,279	203	101	98	48	83.5	7.4	3.7	3.6	1.8
Telephoning	1,170	798	95	115	154	8	68.2	8.1	9.8	13.2	0.7
Number on poles or posts	1,060	753	94	78	128	7	71.0	8.9	7.3	12.1	0.7
All other	110	45	1	37	26	1	40.9	0.9	33.7	23.6	0.9
Special telephones	1,998	1,668	197	112	17	4	83.5	9.9	5.6	0.8	0.2
Police calls received or sent	40,626,505	31,558,693	5,150,225	2,301,511	1,252,408	363,668	77.7	12.7	5.6	3.1	0.9
Telephone	23,393,812	20,430,896	1,439,191	404,791	925,731	193,203	87.3	6.2	1.7	4.0	0.8
All other	17,232,693	11,127,797	3,711,034	1,896,720	326,677	170,465	64.6	21.5	11.0	1.9	1.0
Central office equipment:											
Manual transmitters	83	40	14	19	8	2	48.2	16.9	22.9	9.6	2.4
Automatic transmitters	30	10	7	9	2	2	33.3	23.3	30.0	6.7	6.7
Receiving registers, all kinds	439	311	51	49	21	7	70.8	11.6	11.2	4.8	1.6
Receiving circuits	1,272	826	138	195	90	23	64.9	10.9	15.3	7.1	1.8
Transmitting circuits	983	577	138	166	88	14	58.7	14.0	16.9	9.0	1.4
Telegraph switchboards, number	70	42	12	10	4	2	60.0	17.1	14.3	5.7	2.9
Number of sections	84	49	12	11	9	3	58.3	14.3	13.1	10.7	3.6
Total capacity	578	433	64	59	14	8	74.9	11.1	10.2	2.4	1.4
Telephone switchboards, number	187	142	13	20	11	1	75.9	7.0	10.7	5.9	0.5
Number of sections	224	158	17	33	15	1	70.5	7.6	14.7	6.7	0.5
Total capacity	3,055	2,370	195	201	286	3	77.6	6.4	6.6	9.3	0.1
Single circuits	28	3	3	5	11	6	10.7	10.7	17.9	39.3	21.4
Central station power equipment:											
Motor generators and dynamotors—											
Number	18	8	7	2	1	....	44.4	38.9	11.1	5.6	....
Horsepower	18	8	2	7	1	....	44.4	11.1	38.9	5.6	....
Battery cells—											
Primary	24,477	19,785	1,907	1,178	1,147	460	80.8	7.8	4.8	4.7	1.9
Storage	11,317	4,823	3,439	2,239	742	74	42.6	30.4	19.8	6.6	0.6

The 148 systems reported were distributed as follows: 34 in cities of 100,000 population and over, 30 in cities of 50,000 and under 100,000, 39 in cities of 25,000 and under 50,000, 33 in cities of 10,000 and under 25,000, and 12 in cities and towns of less than 10,000. These 148 plants had a total overhead wire mileage of 17,339 miles, comprising 14,296 miles of single wire and 3,043 miles of single wire in cables, and occupying 3,187 miles of leased pole line and 829 miles of pole line owned by the respective departments. In addition to the overhead construction there were 9,011 miles of wire in underground construction, of which 264 miles were single wire and 8,747 miles single wire in cables. This wire and cable occupied 502 miles of leased conduit and 271 miles of conduit owned by the departments. The circuits thus enumerated were occupied by 9,476 signaling boxes, of which 6,747 were on poles or posts and 2,729 otherwise disposed. There were also 1,170 telephone boxes, of which 1,060 were on poles or posts, leaving 110 in booths, buildings, etc. The number of special telephones used by the departments was 1,998. Over all these instruments 40,626,505 police calls were received or sent, of which 23,393,812 were telephonic and 17,232,693 were of signaling and all other kinds.

The central office equipment of these 148 systems comprised 83 manual transmitters; 30 automatic transmitters; 439 receiving registers; 1,272 receiving circuits; 983 transmitting circuits; 70 telegraph switchboards, with a total capacity of 578 lines; 187 telephone switchboards in 224 sections, with a total capacity of 3,055 drops or circuits; and 28 single circuits, the nature of which has been previously explained in connection with Table 3 of fire alarm systems. The central station power equipment for the operation of this apparatus included 24,477 cells of primary battery, 11,317 cells of storage battery, and 18 motor generators and dynamotors, with a total capacity of 18 horsepower. As in the case of the fire alarm service, the underground construction is practically confined to the larger cities, none of it being found in cities of less than 10,000 population, and only 365 miles out of a total of 9,011 miles of circuit, in cities of less than 100,000 population. The bulk of the signaling apparatus, as of the circuits, whether overhead or underground, is also concentrated in the larger cities, 6,496 signaling boxes, or 68.6 per cent of the total number, being found in cities of a population of 100,000 and over, while of the telephone boxes 798, or 68.2 per cent, were found in cities of the same population group. The work done by the service followed practically the same proportions, 77.7 per cent of the total calls received or sent being limited to the cities in the highest population group. The 10,646 signaling and telephoning boxes reported were distributed over 26,350 miles of circuit, or 1 box to every 2½ miles of circuit. For these 10,646 boxes, the total number of messages sent and received was 40,626,505, giving an average, per box or station, of 3,816 messages during the year, or a daily average use of more than 10 calls. This would appear to be a very extensive use of the systems, and will give some idea of their value and service as a means of increasing the efficiency of the police department and of furnishing aid at times of emergency. It is noticeable that the use of the telephone predominated, the number of telephonic messages being 23,393,812, as compared with 17,232,693 of all other kinds. The difference between the fire alarm and police patrol systems is here sharply indicated. In the case of the former, when a fire breaks out, the chief object is to notify headquarters and near-by engine houses, etc., of the exact location of the fire, which can best be done by having each box preadjusted to transmit a definite signal. On the contrary, in police administration, the occasions which arise for the use of the telephone, aside from locating an officer on his beat, are of a most varied character, requiring, both in transmitting messages to headquarters and in receiving them upon a beat, the giving of a number of specific details, which could not be conveyed by prearranged signals. The inference with regard to the telephonic service is not correct, however, if based upon the number of telephoning boxes only, as it would appear that the 1,998 special telephones should be considered. If, therefore, the number of special telephones be added to the number of telephoning boxes or stations, it would appear that the 3,168 telephones are to be credited each with 7,384 calls sent or received, or about four times as many as the signaling boxes, a striking demonstration of the prominent part played by the telephone in the police patrol system.

The variations in the service are further illustrated by a study of the percentages shown in Table 13. The systems were well distributed, 23 per cent being in cities of 100,000 population and over, 20.3 per cent in cities of 50,000 and under 100,000, 26.3 per cent in cities of 25,000 and under 50,000, 22.3 per cent in cities of 10,000 and under 25,000, and 8.1 per cent in cities and towns of less than 10,000. The table brings out very clearly the fact that cities of 100,000 population and over reported a large proportion of the equipment; and that, extensive as the use of the police signal box and telephone has been shown to be, they are still limited to the larger cities; 68.6 per cent and 68.2 per cent, respectively, of the total number of such boxes were located in cities of 100,000 population and over, while the corresponding percentages for cities in the smallest population group are 3 and 0.7, respectively. Moreover, cities of 100,000 population and over received and sent 77.7 per cent of all police calls, and no less than 87.3 per cent of all telephone messages. Thus there appears to be a large field for the introduction of telephones for police service in the smaller communities, where they would be most useful, the number of officers being few and the population and dwellings being sparsely scattered over a large area.

Table 14 may be studied in conjunction with Table 13, as showing the number of police patrol systems reporting the different items of construction and equipment, grouped according to the population of cities.

TABLE 14.—*Electric police patrol systems reporting different varieties of construction and equipment, grouped according to population of cities: 1902.*

CHARACTER OF CONSTRUCTION AND EQUIPMENT.	NUMBER OF SYSTEMS, BY POPULATION GROUPS.					
	Total.	100,000 and over.	50,000 and under 100,000.	25,000 and under 50,000.	10,000 and under 25,000.	Under 10,000.
Overhead construction:						
Pole line—						
Owned exclusively	14	4	2	4	3	1
Leased exclusively	105	20	19	30	26	10
Owned and leased	29	10	9	5	4	1
Overhead construction exclusively	91	6	19	29	25	12
Underground construction:						
Conduit—						
Owned exclusively	13	5	5	1	2	......
Leased exclusively	35	14	6	9	6	......
Owned and leased	9	9	......	......	......	......
Both overhead and underground construction	57	28	11	10	8	......
Boxes or signaling stations:[1]						
Signaling boxes exclusively	125	28	28	34	24	11
Telephone boxes exclusively	19	4	2	4	8	1
Both signaling and telephone boxes	3	1	......	1	1	......
Special telephones	56	22	11	16	5	2
Central office equipment:						
Manual transmitters exclusively	36	9	6	12	8	1
Automatic transmitters exclusively	13	1	3	6	2	1
Both manual and automatic transmitters	12	4	4	3	......	1
Receiving registers, all kinds	115	30	26	34	19	6
Receiving circuits	120	32	27	34	21	6
Transmitting circuits	112	28	25	33	21	5
Both receiving and transmitting circuits	112	28	25	33	21	5
Telegraph switchboards exclusively	24	3	9	6	4	2
Telephone switchboards exclusively	56	17	9	18	11	1
Both telegraph and telephone switchboards	14	9	3	2	......	......
Single circuits exclusively	28	3	3	5	11	6
Central station power equipment:						
Motor generators and dynamotors	11	7	1	2	1	......
Battery cells—						
Primary	94	22	19	20	24	9
Storage	74	18	20	23	11	2
Both primary and storage	24	6	9	5	3	1

[1] One system reported only telegraphing boxes, which are not shown in this table.

Of the 148 systems considered, 57 used both overhead and underground wires; of these, 28 were in the first population group, 11 in the second, and 10 in the third, or a total of 49 in cities of 25,000 population and over. There were 125 systems which reported signaling boxes only, 19 which reported telephoning boxes only, and 3 which reported both signaling and telephoning boxes. Of the 112 systems using both receiving and transmitting circuits, 28 were in the first population group, 25 in the second, and 33 in the third; and of the 12 systems reporting the use of both manual and automatic transmitters, 11 were in the first three groups. With regard to the power plant, it is interesting to note that 94 plants reported the use of primary batteries, and 74 reported their dependence upon storage batteries; a much larger proportion for the latter than could possibly have been expected. Although, as already noted, only 19 systems reported the use of telephoning boxes exclusively, and 3 the combined use of signaling and telephoning boxes, 56 reported the use of telephone switchboards. It would appear upon the face of it, that such figures must involve discrepancies, but in many of the systems in large cities the boxes are of a combination signal and telephone type, and were reported as signaling boxes only, thus vitiating to a great extent a comparison between the number of telephone boxes and the telephone calls shown in the tables. This fact accounts also for reports of telephone messages or switchboards in cases where there are no returns of telephoning boxes or special telephones.

Table 15 shows the miles of conduit and the wire mileage for the police patrol systems using underground construction, 57 cities being enumerated in 21 states and the District of Columbia.

TABLE 15.—UNDERGROUND CONSTRUCTION OF ELECTRIC POLICE PATROL SYSTEMS, BY STATES AND CITIES: 1902.

STATE OR CITY.	STREET MILES OF CONDUIT.		WIRE MILEAGE.		
	Owned.	Leased.	Total.	Single wire.	Single wire in cables.
United States	271	502	9,011	264	8,747
California	15	15	193	43	150
Los Angeles	....	5	28	28	....
San Francisco	15	10	165	15	150
Connecticut	17	16	62	58	4
Hartford	8	....	10	10	....
New Britain	1	....	1	1	....
New Haven	8	16	51	47	4
District of Columbia	1	6	760	....	760
Washington	1	6	760	....	760
Illinois	56	2	646	2	644
Chicago	54	....	638	....	638
Elgin	....	1	2	....	2
Evanston	2	....	4	2	2
Rockford	....	1	2	....	2
Indiana	7	5	58	2	56
Fort Wayne	....	1	5	....	5
Indianapolis	7	4	53	2	51
Iowa	....	1	2	....	2
Davenport	....	1	2	....	2
Kansas	....	3	27	....	27
Wichita	....	3	27	....	27
Maine	....	4	16	....	16
Portland	....	4	16	....	16
Maryland	....	50	200	....	200
Baltimore	....	50	200	....	200
Massachusetts	22	108	583	102	481
Boston	6	36	315	....	315
Brookline	....	16	45	26	19
Cambridge	....	1	3	....	3
Clinton	....	1	2	....	2
Fall River	....	9	47	....	47
Holyoke	....	5	9	1	8
Lowell	....	5	39	....	39
New Bedford	6	....	22	6	16
Newton	....	2	9	4	5
Quincy	10	....	20	....	20
Springfield	....	12	40	40	....
Waltham	....	2	5	....	5
Worcester	....	19	27	25	2
Michigan	22	....	273	....	273
Detroit	20	....	260	....	260
Grand Rapids	2	....	13	....	13
Minnesota	2	23	358	....	358
Minneapolis	2	3	200	....	200
St. Paul	....	20	158	....	158
Missouri	4	10	505	....	505
St. Joseph	....	10	50	....	50
St. Louis	4	....	455	....	455
Nebraska	....	3	22	....	22
Omaha	....	3	22	....	22
New Jersey	....	11	86	2	84
Newark	....	9	84	....	84
Paterson	....	2	2	2	....
New York	7	60	584	....	584
Albany	....	4	20	....	20
Buffalo	....	20	97	....	97
Elmira	....	5	12	....	12
New York[1]	7	18	440	....	440
Rochester	....	13	15	....	15
Ohio	....	32	208	....	208
Akron	....	1	23	....	23
Canton	....	1	2	....	2
Cincinnati	....	20	158	....	158
Cleveland	....	10	25	....	25
Pennsylvania	85	137	4,224	53	4,171
Allegheny	....	84	252	....	252
Erie	1	....	3	....	3
Philadelphia	75	53	3,905	53	3,852
Pittsburg	9	....	64	....	64
Rhode Island	1	10	68	....	68
Newport	....	5	13	....	13
Providence	1	5	55	....	55
Virginia	....	6	14	....	14
Norfolk	....	1	4	....	4
Richmond	....	5	10	....	10
Washington	2	....	2	2	....
Seattle	2	....	2	2	....
Wisconsin	30	....	120	....	120
Milwaukee	30	....	120	....	120

[1] Has 4 separate systems, but is treated as 1 system.

The 57 systems shown in Table 15 owned 271 street miles of conduit and leased 502 miles in addition. The total wire mileage underground was 9,011 miles, of which 8,747 miles were single wire in cables, and the remaining 264 miles consisted of single wires strung separately.

Table 16 presents the statistics of police patrol systems by states.

TABLE 16.—ELECTRIC POLICE PATROL

	STATE OR TERRITORY.	Number of systems.	CHARACTER OF CONSTRUCTION.										NUMBER AND CHARACTER OF BOXES OR SIGNALING STATIONS.					
			Overhead.					Underground.					Signaling.			Telephoning.		
			Miles of pole line.		Wire mileage.			Street miles of conduit.		Wire mileage.								
			Owned.	Leased.	Total.	Single wire.	Single wire in cables.	Owned.	Leased.	Total.	Single wire.	Single wire in cables.	Total.	Number on poles or posts.	All other.	Total.	Number on poles or posts.	All other.
1	United States....	148	829	3,187	17,339	14,296	3,043	271	502	9,011	264	8,747	9,476	6,747	2,729	1,170	1,060	110
2	Alabama	2		25	50	50							65	65				
3	California	3	75	96	1,094	1,069	25	15	15	193	43	150	850	750	100	50	50	
4	Colorado	2	30	49	139	139							117	21	96			
5	Connecticut	6	2	64	112	108	4	17	16	62	58	4	147	143	4			
6	Delaware	1		60	140	136	4						44	44				
7	District of Columbia	1	(1)	(1)	(1)	(1)	(1)	1	6	760		760	307	261	46	200	200	
8	Florida	3	2	20	53	53							54	54		11	11	
9	Georgia	4	39	61	165	145	20						105	86	19	45	44	1
10	Illinois	12	113	326	1,753	1,750	3	56	2	646	2	644	1,327	282	1,045			
11	Indiana	4	7	109	275	275		7	5	58	2	56	165	144	21			
12	Iowa	3	4	42	65	58	7		1	2		2	43	26	17	26	26	
13	Kansas	1		4	11	8	3		3	27		27				10	10	
14	Maine	2		16	46	46			4	16		16	51	48	3			
15	Maryland	1	5	15	300	300			50	200		200	260	260				
16	Massachusetts	28	17	488	1,145	766	379	22	108	583	102	481	1,257	978	279	62	50	12
17	Michigan	5	34	38	397	397		22		273		273	346	290	56			
18	Minnesota	3	18	100	573	573		2	23	358		358	229	137	92			
19	Missouri	3	80	107	2,101	2,042	59	4	10	505		505				490	483	7
20	Montana	1		13	25	25							27	27				
21	Nebraska	1		40	74	53	21		3	22		22				46	8	38
22	New Hampshire	1		2	2	2							7	7				
23	New Jersey	8	62	161	2,772	463	2,309		11	86	2	84	457	452	5	17	17	
24	New York	[2]14	28	455	1,651	1,488	163	7	60	584		584	938	653	285	47	44	3
25	North Dakota	1		2	2	2										8	7	1
26	Ohio	11	20	324	721	683	38		32	208		208	680	530	150	82	62	20
27	Oregon	1		12	24	24							25		25			
28	Pennsylvania	11	240	299	2,934	2,932	2	85	137	4,224	53	4,171	1,228	983	245	25	25	
29	Rhode Island	3	1	64	186	180	6	1	10	68		68	168	168		23	23	
30	South Carolina	1	2	20	55	55							54	54				
31	Tennessee	1		11	35	35							18	17	1			
32	Virginia	2	4	18	52	52			6	14		14	27	27		28		28
33	Washington	2	3	45	93	93		2		2	2		153	146	7			
34	Wisconsin	6	43	101	294	294		30		120		120	327	94	233			

[1] Not reported.

[2] New York city has 4 separate systems, but is treated as 1 system.

SYSTEMS, BY STATES: 1902.

Special telephones.	POLICE CALLS RECEIVED OR SENT. Telephone.	POLICE CALLS RECEIVED OR SENT. All other.	CENTRAL OFFICE EQUIPMENT. Transmitters. Manual.	CENTRAL OFFICE EQUIPMENT. Transmitters. Automatic.	Receiving registers, all kinds.	Receiving circuits.	Transmitting circuits.	Telegraph switchboards. Number.	Telegraph switchboards. Number of sections.	Telegraph switchboards. Total capacity.	Telephone switchboards. Number.	Telephone switchboards. Number of sections.	Telephone switchboards. Total capacity.	Single circuits.	CENTRAL STATION POWER EQUIPMENT. Motor generators and dynamotors. Number.	Motor generators and dynamotors. Horsepower.	Battery cells. Primary.	Battery cells. Storage.	
1,998	23,393,812	17,232,693	83	30	439	1,272	983	70	84	578	187	224	3,055	28	18	18	24,477	11,317	1
...	...	15,800	...	...	2	10	4	...	...	...	1	6	8	...	...	...	75	35	2
50	95,208	782,131	2	...	13	50	28	7	11	51	2	2	120	...	...	...	5,665	356	3
12	605,400	...	...	...	9	9	2	1	1	10	1	1	20	1	...	...	47	150	4
29	96,814	269,010	...	1	4	59	59	2	2	8	7	51	100	1	...	...	484	206	5
...	(1)	(1)	3	1	2	3	3	...	...	...	...	...	...	...	...	...	50	450	6
...	1,226,400	212,671	1	2	3	30	14	...	...	...	2	3	250	...	1	1	...	906	7
2	13,961	13,735	1	1	2	6	6	1	4	4	1	1	4	1	...	...	145	38	8
2	247,055	426,873	2	2	4	16	10	2	2	8	...	...	...	...	...	...	125	236	9
...	4,224,866	250,490	3	1	101	101	22	...	...	...	47	4	161	5	1	1	1,999	793	10
...	60,384	453,916	1	1	4	15	3	2	5	16	1	5	50	2	...	...	112	314	11
7	158,758	169,660	1	1	6	82	32	...	...	...	...	...	...	...	...	...	52	180	12
...	56,039	...	1	...	...	10	10	...	...	...	1	1	20	...	...	...	20	...	13
14	...	241,727	...	1	3	6	5	...	...	...	1	1	5	...	...	...	110	96	14
15	876,000	295,101	...	...	18	43	24	1	1	8	19	19	43	...	...	...	1,218	...	15
252	1,673,872	6,069,828	15	5	54	114	121	7	7	29	16	19	141	3	8	3	2,465	1,876	16
41	1,254,020	26,505	1	1	27	25	24	...	...	...	3	3	45	2	2	2	204	561	17
38	157,634	162,375	1	...	11	160	147	4	4	36	8	8	224	...	...	...	96	220	18
259	1,510,288	538,216	9	1	9	58	27	15	15	185	3	3	185	1	1	1	1,759	282	19
3	(1)	(1)	1	...	1	4	1	...	...	...	1	1	5	...	...	...	...	50	20
1	219,000	4,856	...	...	5	4	...	...	...	...	1	1	20	...	...	...	...	150	21
...	...	5,475	...	...	1	7	...	...	...	...	...	...	...	...	...	...	...	...	22
29	231,306	890,584	14	...	18	51	35	8	8	50	3	3	30	1	...	...	1,268	474	23
279	1,541,134	3,819,003	8	1	39	123	113	4	7	45	11	24	719	2	2	2	3,578	1,292	24
...	54,750	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	25
71	1,392,904	771,534	2	2	22	102	84	4	4	26	8	9	239	1	2	7	738	221	26
...	...	175,200	...	...	1	3	...	...	...	...	...	...	...	...	...	...	100	...	27
799	6,901,355	705,962	9	2	52	96	86	9	10	76	44	47	397	2	...	...	2,478	1,261	28
18	106,382	693,635	7	4	2	67	64	...	...	...	1	1	4	1	...	...	1,349	...	29
...	2,778	87,424	...	...	1	3	3	...	...	...	1	1	4	...	...	...	...	62	30
4	...	73,000	...	1	1	4	4	...	...	...	1	1	50	...	...	...	140	...	31
1	1,225	892	...	...	4	7	7	1	1	4	1	1	6	...	...	...	50	60	32
40	5,444	71,320	1	1	8	14	14	1	1	12	1	5	100	...	...	...	40	446	33
32	680,835	5,770	...	1	12	40	31	1	1	10	1	3	105	4	1	1	110	602	34

The 148 police patrol systems were distributed in 32 states and the District of Columbia. Massachusetts is credited with the largest number, 28; New York comes next with 14; but in the latter case it should be noted that New York city, which has 4 separate systems, is counted as only 1 system. Illinois has 12 systems; Ohio and Pennsylvania, each 11; New Jersey, 8; and Connecticut and Wisconsin, each 6. It appears from the table that the number of police calls sent or received by telephone was 6,901,355 in Pennsylvania, and 4,224,866 in Illinois, the state next in rank. The large proportion in Illinois is due to the extensive use of the telephone in the city of Chicago. In 1902 New York had 938 signaling and 47 telephoning boxes, and 279 special telephones, with which 5,360,137 calls or messages of all kinds were sent or received; but, as noted elsewhere, since the time of this report the borough of Manhattan has contracted for no fewer than 661 police patrol stations, to be operated in conjunction with the local telephone system. It is to be noted, in fact, that the number of special telephones reported in 1902 was considerably larger than the number of telephoning boxes specifically described as such, but it has already been explained that a considerable number of systems reporting signaling boxes used a combination system of signaling and telephoning.

The foregoing table indicates that most of the police patrol systems are located in those states having the greatest number of large cities; but it is probable that the extension of the telephone throughout the rural districts has made greater progress than appears from the figures here presented, for it is a matter of record that the use of the farmers' telephones in rural districts has greatly lessened the labor of sheriffs and constables in connection with suppressing the "tramp nuisance."

HISTORICAL AND DESCRIPTIVE.

The utilization of the telegraph as an aid in the detection and suppression of crime, and also in connection with other duties falling to the protectors of the peace, was quite early resorted to by the police departments in various large cities. In fact, one of the very earliest instances of the use of the telegraph in England—and that which did most to direct public attention to it at that time—was the forwarding from one city to another of a telegram describing an escaped murderer, who was promptly arrested by means of the assistance thus given. In the leading American cities the practice early took root of employing telegraph operators at headquarters, as members of the force, to transmit messages and receive signals over wires connected with the police stations in the various precincts. In 1858 the firm of Charles T. & J. N. Chester made for the New York city police department a dial telegraph, which soon afterwards was adopted also by Philadelphia.

It is obvious, however, that this practice, if based simply upon Morse telegraphy with the use of the key and sounder, or even with the aid of the Morse register, would involve an undue and expensive staff of operators, and these conditions could not be greatly improved even by the use of the dial system, wherein the operation of an electrical apparatus with a keyboard something like that of a typewriter enables a message to be sent directly in letters of the alphabet, thus avoiding the necessity of first translating them into dots and dashes and then having them translated back again. In the case of fire alarm telegraphs, a mere notification by numerals suffices to give the required alarm and bring prompt assistance; but in the case of police patrols, the facts transmitted in each case are so varied in character as to require specific details, and even the brief delay of putting a message into the Morse code or into a cipher would consume too much time.

Under these circumstances it was natural that resort should be had to the telephone; and the evidence goes to show that the combination of the telegraph and telephone as an auxiliary to the police force was first introduced in 1880 in the city of Chicago by J. P. Barrett, then superintendent of the electrical department of that city. The system was first installed in one of the most turbulent districts of the city, and at once increased tremendously the efficiency of the force, chiefly in the way of making possible a rapid concentration at any troubled point. Its success was so rapid that by 1893 no fewer than 1,000 street stations had been installed all over the city of Chicago, and in addition several hundred private boxes had also been put in, giving instant communication, at any hour of the day or night, with all the stations of every precinct. Since that time the idea has been carried even farther in various ways, as the accompanying report shows, not only in Chicago, but in other cities. Milwaukee was the second city to adopt the police telephone booth, the installation being made in 1883. Brooklyn followed in February, 1884, with many improvements, which appear to have been made there for the first time. Upon the suggestion of Frank C. Mason, superintendent of the police telegraph bureau, iron boxes, similar to those employed in fire alarm telegraphy, were used instead of the unsightly booth. Philadelphia, however, adhered to the booth, introducing it in July, 1884; since that time the system has been extended year by year, and some of the more modern street boxes have been introduced.

As the work in Chicago is typical, and is the fundamental form from which the others have been evolved, a brief description of it may be given. A special feature was the adoption, for street stations, of an octagonal booth or inclosure about 8 feet high and 2 feet 4 inches in diameter. For many reasons such sentry boxes are preferable to boxes on walls or lamp-posts, as the patrolman once within is secure from interruption while communicating with headquarters, and, moreover, the intelligence he wishes to convey can be kept secret—a matter of considerable importance on many occasions. Keys which will open any of the street stations and boxes are given to the patrolmen of the district, and are also placed in the hands of responsible citizens, the names of the citizens and the numbers of the keys being carefully recorded. The citizen's key only turns in a call for help, but the patrolman's key gives him access to the inner box, from which he can transmit calls, signals, and reports, by means of telephone receivers and transmitters and other apparatus.

The private boxes placed in residences, banks, hotels, etc., enable the persons using them to call up the police at any time by simply turning in an alarm; by pulling the lever or handle attached to the box, as in the case of the district messenger boxes, the nature of the trouble can be indicated roughly. At the police station is kept, under seal, a key of the house employing the signal box, so that upon arrival the police can immediately let themselves in and proceed to business. Each night, the renter of the alarm box can make a test of the system, an answering ring showing the line to be in working order; in the same way, after an alarm has been sent in, a return tap signal of the bell gives assurance that the call has been heard and will be attended to immediately.

Notwithstanding the advantage of being able to carry on a conversation by telephone, there is a certain advantage in automatic signaling, as there can be no variation, and no wrong idea can be conveyed by an excited dispatcher to a confused operator at central who can not understand what is being said.

In addition to the telephone system and the automatic signals, visual signals were introduced. Semaphores were used by day and flash lights by night, by utilizing either ordinary lamp-posts or lamps placed on top of the booths; an additional feature was the ringing of a large bell. Not only are the visual signals used as a means of registering the proper circulation of patrolmen on their beats, but they have this advantage—they can be operated on all the boxes on any one circuit.

The systems of the present day are analogous to that which has just been outlined, the signal box being provided with a telephone, by means of which patrolmen can communicate with police headquarters. The telephone is supplemented, however, by other apparatus for signaling and telegraph purposes. For example, with one type of box the patrolman advises the central office of his being on duty by opening the box with a special key, thus transmitting the number of the box, which, with the time, is recorded automatically upon a slip of paper by an electric time stamp. These signals are transmitted at a higher rate than fire alarm signals, for the reason that no heavy apparatus, such as a gong, is used. These signals may be said to correspond in their nature to those of a watchman's automatic registering system, being received by the central office mechanically, without intervention of an operator. The mechanism of the box is so arranged that when a signal requiring immediate attention is sent in, a local circuit is closed by a bell magnet, thus calling special attention to the incoming signal. A further modification makes it possible, in case an officer on the beat has requested the dispatch of a police wagon or ambulance, to convey or transfer the signal to the stables; in this event the call is transferred by the operator to the dial mechanism communicating with the stables, a lever is pulled, and the number of the box is sent over the circuit to the stables, where it is both struck by the gong and exhibited visually on an indicator.

As already stated, police patrol boxes are sometimes fitted with two keys, and the boxes ordinarily in use in the large cities are of this type. Such boxes usually have both an outer and an inner door, the object of the outer one being generally to limit the extent to which the private citizen can utilize the box. When the key has once been put in the "citizen" keyhole and turned, it can not be withdrawn until the outer door has been opened, whereupon the signal is transmitted to headquarters. The patrolman on his rounds opens the doors, and, if he wishes merely to report his presence there, places the point of the small dial at the top of the plate inside at the "report" section, when an answering signal within the box will inform him that his report has been received at headquarters and that he may proceed on his rounds. Should it be desired by "central" to hold him for instructions, a definite number of strokes on the bell notifies him to use the telephone, which hangs in the inner box. This signal can be sent to any box, even in the absence of the central office attendant, thus obviating the possibility of the policeman getting away before the special call can reach him.

Another form of box is fitted with the keyless door, which can be opened by any citizen desiring to use it, the turning of the handle sounding an alarm on a gong and thus notifying any policeman at another box on the same beat that it is in use. In some systems provision is made whereby the patrolman is unable to prevent the box from keeping automatically a faithful record of his movements; for instance, a policeman could not remain at one box and from there, at the proper time, send in false signals purporting to come from other boxes at different points on his beat. It is obvious that many other modifications and changes can be introduced, according to local requirements and conditions, but the features here outlined are those which are most generally used at the present time.

A remarkable proof of the enlarged scope given the service by the use of the facilities of the modern telephone exchange is afforded by the latest development of the telephonic police signal system recently put in operation in the city of New York. This system was determined upon early in 1903, after several conferences between Prof. G. F. Sever, consulting electrical engineer on behalf of the city, and the representatives of the New York Telephone Company, held at the office of Police Commissioner Greene. It was decided to install in the borough of Manhattan no fewer than 661 police telephone stations, from 20 to 30 in each of the 29 police patrol precincts. After a careful and thorough investigation it was decided to eliminate from this system all signal appliances aside from the telephone itself, it being held that everything provided for in the ordinary combination signal and telephone box, and much more, could be done through the telephone station.

A station consists of a telephone transmitter and receiver and a call bell placed in a cast iron box securely fastened to the wall of a building; six of these telephone stations comprise one circuit. Each patrolman is provided with a key, and is required to report to the station house at a designated time in each hour; if he is delayed more than fifteen minutes a roundsman is detailed to investigate the reason for the omission of the call. It is held that there is no possibility whatever of turning in an improper report, as the operator at the central station, who knows all the men, can always recognize the voice of the patrolman, and can determine from the signal the box from which the call is made.

In the station house in each precinct there is installed a small switchboard operated by specially detailed patrolmen. The operator at this switchboard records the box and the time at which each patrolman reports, as well as all other messages in the nature of ambulance and patrol wagon calls, reports of riots, and other exceptional occurrences; he also telephones to police station stables for patrol wagons and to hospitals for ambulances.

One improvement which it is thought may be desirable is the abolition of the circuits having telephones in series groups of six, in favor of a system in which each instrument is on a separate metallic circuit, and is provided with two individual wires, as is generally the case in the modern telephone system in every large city. This arrangement would absolutely eliminate the possibility, if there is any, of collusion on the part of patrolmen with regard to reporting at the proper time but at a different box from that at which the call should be turned in.

All the work of installation, maintenance, and operation, outside of that of the operator at the switchboard, is looked after by the New York Telephone Company, the police department paying an annual rental for the use of the apparatus. This arrangement obviates the necessity for the maintenance by the police department of a corps of skilled men to maintain and operate such a signal system as would, under ordinary circumstances, be owned by the city; and it virtually places at the command of the police department all the resources of a modern telephone exchange with its engineering staff. It is impossible to make any estimate of the results obtainable with this system, which at the time of writing has been installed in but one precinct, and it still remains to be seen whether it is not better for the city to maintain its own apparatus and staff.

With regard to the subject of ambulance alarm circuits in hospitals and public institutions—a branch of the work still in a somewhat unorganized condition—it would appear that in New York city almost all ambulance calls are sent in from either public or private telephone stations; a patrolman sends the call to the central police headquarters in Mulberry street, whence it is transmitted to the hospital nearest the scene of accident or trouble. The city fire alarm circuits also are sometimes used for sending in ambulance calls to fire headquarters, whence they are transmitted by telephone either to the nearest hospital or to police headquarters, as, for example, when a fire chief, being near the scene of an accident, avails himself of the facilities of his department in securing prompt relief.

SPECIAL FEATURES.

The tables and statistical matter presented in this report deal with a great variety of apparatus; in the course of years, however, the essential features have been standardized, so that the differences in practice are of a minor character, such as belong rather to the minutiae of technique than to questions in which the public is interested, and hence need hardly be noticed in a report of this character. The apparatus referred to is essentially a manufactured product, bought in the open market, usually under competitive bids, but a great many of the departments have their own repair shops, many of which do work of an extensive character; for example, at San Francisco the repair shops under the department of electricity not only attend to all general repairs, but manufacture all the signaling devices used on the system.

The statistics have also brought out the fact that the systems are so overwhelmingly municipal in ownership and operation as to render it unnecessary to make a separate classification of those under private ownership. It may be noted, however, that some of the systems have been installed under conditions of peculiar or special arrangement with local service companies. The system at West Chester, Pa., for example, was installed and is kept in operation and repair by the Edison Electric Illuminating Company without expense to the town. At Deadwood, S. Dak., the system was installed, without cost to the city, by the Black Hills Electric Light Company. In a great many instances current for operating the services is furnished by local lighting or street railway companies, either for the exclusive operation of the plant or as a supplement to the power plant belonging to the system. It is interesting to note that the current for charging the storage batteries of the Buffalo fire alarm system is obtained from the power company at Niagara Falls, over twenty miles away. At Carbondale, Pa., the storage batteries of the system are charged with 500 volts current from the Scranton Street Railway Company's power plant. At Lawrence, Mass., the current is reported as being furnished by the local electric light company.

In connection with the fire alarm system at Detroit, Mich., it is reported that a portable pocket telephone, plugging into a suitable jack, is used to communicate from the fire alarm boxes with the central office, the receivers and transmitters being in series. This device is stated to have been used satisfactorily for the past five years.

In Atlantic City, N. J., it is stated that 90 per cent of all night fire alarms are now turned in by the police officers, as compared with 10 per cent previous to the establishment of the police patrol system. Of the 38 cities having 100,000 or more inhabitants, 20 did not use manual or automatic transmitters in connection with their police patrol systems.

Rochester, N. Y., claims to be the first city in the United States to install on all police telephone circuits a central energy telephone system—that is, a system in which all the energizing and operating current is furnished from the central exchange, as in modern telephone practice in the larger cities; the signaling circuits of this system are operated without using ground connections, condensers, or other paraphernalia in the patrol boxes. Rochester claims also that it was the first city in New York state to adopt a police telegraph system. Its police telegraph boxes are supplied with a special system of cut-outs, as a protection against being burned out by abnormal currents. In this connection it may be noted that the fire alarm system at Portsmouth, N. H., has obviated the blowing out of fuses, frequently occasioned by the proximity of heavily charged cross wires, by detaching the ground wires from all boxes and other apparatus, excepting the one used in connection with the testing switches. At Millbury, Mass., the trouble caused by lightning striking the fire alarm circuits has been obviated by a relay so adjusted that the least excess of current cuts in an emergency set of batteries. Other instances of variation and of special effort to improve the efficiency of the two systems might be enumerated.

18407—06——11

APPENDICES

APPENDIX A.—SCHEDULES

APPENDIX B.—INSTRUCTIONS TO SPECIAL AGENTS

APPENDIX A.

SCHEDULES.

SPECIAL SCHEDULE NO. 19.—TELEPHONE COMPANIES.

Name of company, ...

....

State, ... City, ...

General offices at (give state, city, street, and number), ...

....

UNITED STATES CENSUS OFFICE,
Washington, D. C., July 1, 1903.

By section 7 of the act of Congress for the establishment of a permanent Census Office, approved March 6, 1902, the Director of the Census is required to prepare a report on the telephone companies of the United States, and the following schedule has been formulated for that purpose.

Mr. Thomas Commerford Martin, of New York city, expert special agent, is in charge of the electrical branch of this inquiry.

The information returned on this schedule should cover the business year of the establishment most nearly conforming to the year ending December 31, 1902. All questions that require a fixed time, such as cash on hand, etc., should be of the date of the last day of the year covered by the report.

Answers to questions concerning financial operations will be held absolutely confidential.

S. N. D. NORTH,
Director of the Census.

Extract from act of Congress, March 3, 1899:

Section 22.—* * * "And every president, treasurer, secretary, director, agent, or other officer of every corporation, and every establishment of productive industry, whether conducted as a corporate body, limited liability company, or by private individuals, from which answers to any of the schedules, inquiries, or statistical interrogatories provided for by this act are herein required, who shall, if thereto requested by the Director, supervisor, enumerator, or special agent, willfully neglect or refuse to give true and complete answers to any inquiries authorized by this act, or shall willfully give false information, shall be guilty of a misdemeanor, and upon conviction thereof shall be fined not exceeding ten thousand dollars, to which may be added imprisonment for a period not exceeding one year."

CERTIFICATE.

This is to certify that the information contained in this schedule is complete and correct to the best of my knowledge and belief, and it covers the period from ......, 190.., to ......, 190...

....

(Signature and official designation of the person furnishing the information.)

1. Does company do telephone business? .... Telegraph business? ....
(Answer Yes or No.)
2. Date when this exchange system was first established: ....
3. Date when present company was incorporated: ....
State in which incorporated: ....
4. Is this company a combination of other plants or companies? ....
5. States in which operated: ....
6. Cities, towns, or villages in which operated (companies will kindly send list of exchanges and toll stations or write same on last page): ......
7. Employees, salaries, and wages:
(The average number employed during the year is the number that would be required, at continuous employment, for the twelve months. If any of the persons enumerated were employed at incidental times, explain methods of employment.)
8. Average number of employees at specified weekly rates of pay:

	Average number during the year.	Salaries and wages paid during the year.
General officers	....	$..........
Other officers, superintendents, general managers, exchange managers, electricians, and experts	....	....
Clerks and bookkeepers (and all others not indicated below)	....	....
Operators:		
Male	....	....
Female	....	....
Foremen	....	....
Inspectors	....	....
Linemen of all classes	....	....
Wiremen and batterymen	....	....
Troublemen	....	....
All other employees	....	....
Total	....	$..........

8. Average number of employees at specified weekly rates of pay:

Weekly rates.	OPERATORS.				Foremen.	Inspectors.	Linemen.	Batterymen.	Troublemen.	All other employees.	Other weekly rates of pay.	OPERATORS.				Foremen.	Inspectors.	Linemen.	Batterymen.	Troublemen.	All other employees.
	Male.		Female.									Male.		Female.							
	16 and over.	Under 16.	16 and over.	Under 16.								16 and over.	Under 16.	16 and over.	Under 16.						
$3																					
4																					
5																					
6																					
7																					
8																					
9																					
10																					
11																					
12																					
13																					
14																					
15																					
16																					
17																					
18																					
19																					
20																					

Of the total number of employees, give number working six days in the week, ...; seven days, ...

Are employees allowed one day in seven for their own use? .... If Sunday labor is paid for extra, mention the rate per hour, ... Rate of pay per hour for overtime, ... How many hours constitute a day's work? For operators, ...; for messengers, ...; other employees. ....

Explain method of working by shifts: ....

9. Construction, subways or conduits:

KIND.	OWNED AND USED BY THIS COMPANY.				LEASED FROM OTHER COMPANIES OR FROM MUNICIPALITY.		
	Miles of street occupied by subway or conduit.	Total miles of duct.	Total wire mileage.		Total miles of duct.	Total wire mileage.	
			Cable.	Single wire.		Cable.	Single wire.
Concrete							
Terra cotta and vitrified clay							
Iron pipe, plain or lined with cement							
Wooden duct, etc							

Miles of submarine cable, ...; miles of submarine cable circuit in wire, ...

10. **Construction, overhead lines:**
Miles of pole line for wires or cables, ...; miles of single wire on pole and roof line, ...; miles of overhead cables, ...; miles of circuit in wire in overhead cables, ...

11. Poles:
(1) Kind of wood: ....
(2) Sources of supply; State: ....
(3) Specifications and prices:

YEAR.	Average price per pole.	DIAMETER. Butt.	DIAMETER. Top.	Soundness.	YEAR.	Average price per pole.	DIAMETER. Butt.	DIAMETER. Top.	Soundness.
1891	$				1897	$			
1892					1898				
1893					1899				
1894					1900				
1895					1901				
1896					1902				

REMARKS.—Please give any other particulars of interest regarding specifications: ....

(4) Seasoning—manner: ....
Time required: ...... Average weight of poles, seasoned, ...; unseasoned, ...
REMARKS.—Please give any further particulars of interest concerning seasoning: ....

(5) Preservative treatment. Average life of poles, treated, ...; untreated, ...
Describe process in detail: ....

12. Total miles of wire in operation each year since 1890:

YEAR.	Miles.	YEAR.	Miles.
1891		1897	
1892		1898	
1893		1899	
1894		1900	
1895		1901	
1896		1902	

13. Total number of messages, or talks, handled by this exchange system during the year (except on private exchange wires): .... Of these, how many long distance? .... Total number of subscribers December 31, 1902: ....
14. Total number of toll connections during the year, not including long distance: ....
15. What kind of rate, if any, flat, graduated, measured, or other, is compulsory under law or franchise? ....
16. Charges for service—Flat rate, for residence, ...; business, ... Measured service—When adopted, ...; rates, ... (Give full description on last page of schedule and furnish copy of tariff.)
17. Number of farmer mutual or cooperative rural lines, ... Wire mileage, ... Total number of subscribers on such lines, ... (Included in answer to question 13, but here separated.)
18. Telephone switchboards, power plant, and batteries:

KIND.	Number.	KIND.	Number.	Total horsepower.
Manual switchboards		Engines		
a. Common battery system		Dynamos		
b. Magneto system		Electric motors for telephone service		
Automatic switchboards				

Total capacity of switchboards, ...; number of auxiliary cross-connection boards, distributing frames, etc., ...; central office magneto-generators, ringers, etc., number, ...; primary batteries, number of cells, ...; storage batteries, number of cells, ...

19. Total number of public exchanges and public branch offices, ...; total number of private branch exchanges, ...; number of automatic or nickel-in-slot pay stations, ...; number of other pay stations, ...; total number of party lines, ...; total number of stations on party lines, ...

20. Total stations (boxes or telephones) of all kinds in operation at the end of each year since 1890:

YEAR.	Number.	YEAR.	Number.
1891		1897	
1892		1898	
1893		1899	
1894		1900	
1895		1901	
1896		1902	

21. Capital stock, bonds, and dividends:

	Number of shares or bonds.	Total par value.	DIVIDENDS AND INTEREST. Rate.	DIVIDENDS AND INTEREST. Amount.
Authorized capitalization:				
Common stock		$		$
Preferred stock				
Bonds				
Capital stock and bonds issued:				
Common stock				
Preferred stock				
Bonds				

22. Stocks and bonds authorized and issued since 1890, with dividends and interest:

YEAR.	STOCK. Authorized.	STOCK. Outstanding at end of year.	STOCK. Dividends.	YEAR.	BONDS. Authorized.	BONDS. Outstanding at end of year.	BONDS. Interest.
1891	$	$	$	1891	$	$	$
1892				1892			
1893				1893			
1894				1894			
1895				1895			
1896				1896			
1897				1897			
1898				1898			
1899				1899			
1900				1900			
1901				1901			
1902				1902			

23. Revenue and expenses:
Revenue—

Gross receipts from telephone business	$
Dividends from other companies or other sources	
Leased telephone lines, wires, and conduits	
Real estate	
Interest	
Miscellaneous (specify items)	
Total	$

23. Revenue and expenses—Continued.

Expenses—

General operation and maintenance	$........
Legal expenses	....
Rentals and royalties on instruments	....
Rentals of offices and other real estate	....
Rentals of conduits and underground privileges	....
Telephone traffic (paid or due to other companies)	....
Miscellaneous	....
Interest on floating debt	....
Interest on funded debt, paid or accrued	....
Taxes of all description	....
Paid for use of leased lines	....
Dividends paid or accrued	....
Carried to reserve	....
Carried to surplus	....
Total	$........
Cost of lines, real estate, equipment, etc., added during the year (indicate whether by purchase or construction).	....

24. Balance sheet:

ASSETS.		LIABILITIES.	
Kind.	Amount.	Kind.	Amount.
Construction and equipment (not including telephones)	$........	Capital stock	$........
Telephones	....	Bonds	....
Real estate	....	Reserves	....
Stocks and bonds of other telephone or of telegraph companies	....	Bills and accounts payable	....
Other stocks and bonds	....	Dividends unpaid	....
Machinery, tools, and supplies	....	Surplus	....
Bills and accounts receivable	....	....	....
Cash and deposits	....	....	....
....	....	....	....
....	....	....	....
Total	$........	Total	$........

REMARKS.

(To be used for list of exchanges and toll stations, and for description of tariff charges. See inquiries 6 and 16.)

....

....

SPECIAL SCHEDULE NO. 21.—TELEGRAPH COMPANIES.

Name of company..

....

State.......................... City..........................

General offices at (give state, city, street, and number)..............

....

UNITED STATES CENSUS OFFICE,
Washington, D. C., July 1, 1903.

By section 7 of the act of Congress for the establishment of a permanent Census Office, approved March 6, 1902, the Director of the Census is required to prepare a report on the telegraph companies of the United States, and the following schedule has been formulated for that purpose.

Mr. Thomas Commerford Martin, of New York city, expert special agent, is in charge of the electrical branch of this inquiry.

The information returned on this schedule should cover the business year of the establishment most nearly conforming to the year ending December 31, 1902. All questions that require a fixed time, such as cash on hand, etc., should be of the date of the last day of the year covered by the report.

Answers to questions concerning financial operations will be held absolutely confidential.

S. N. D. NORTH,
Director of the Census.

Extract from act of Congress, March 3, 1899:

SEC. 22. * * * "And every president, treasurer, secretary, director, agent, or other officer of every corporation, and every establishment of productive industry, whether conducted as a corporate body, limited liability company, or by private individuals, from which answers to any of the schedules, inquiries, or statistical interrogatories provided for by this act are herein required, who shall, if thereto requested by the Director, supervisor, enumerator, or special agent, willfully neglect or refuse to give true and complete answers to any inquiries authorized by this act, or shall willfully give false information, shall be guilty of a misdemeanor, and upon conviction thereof shall be fined not exceeding ten thousand dollars, to which may be added imprisonment for a period not exceeding one year."

CERTIFICATE.

This is to certify that the information contained in this schedule is complete and correct to the best of my knowledge and belief, and it covers the period from ......, 190 , to ......, 190 .

....

(Signature and official designation of the person furnishing the information.)

1. Does company do telegraph business? ...... Land telegraph? ...... Ocean telegraph? ...... Railway telegraph? ...... Telephone business? .... (Answer Yes or No.)
2. Date when this company or system began operations: ......
3. Date when present company was incorporated: ...... State in which incorporated: ......
4. Is this company a combination of other plants or companies? ......
5. States in which operated: ......
6. Cities, towns, or villages in which operated (companies will kindly send list of offices): ....

....

7. Employees, salaries, and wages:

(The average number employed during the year is the number that would be required, at continuous employment, for the twelve months. If any of the persons enumerated were employed at incidental times, explain methods of employment. Do not include operators, etc., employed at railway offices and paid by railway company under agreement or understanding with telegraph company as to use of telegraph company's lines.)

	Average number during the year.	Salaries and wages paid during the year.
Corporation officers (elected or appointed)	....	$........
General officers	....	....
All other employees in general offices	....	....
Managers and clerks in operating department	....	....
Operators:		
Male	....	....
Female	....	....
Inspectors or section linemen	....	....
Linemen	....	....
Messengers	....	....
All other employees	....	....
Total	....	$........

8. Average number of employees at specified weekly rates of pay:

Weekly rates.	Operators.				Inspectors or section linemen.	Linemen.	Messengers.[1]	All other employees.	Other weekly rates of pay.	Operators.				Inspectors or section linemen.	Linemen.	Messengers.[1]	All other employees.
	Male.		Female.							Male.		Female.					
	16 and over.	Under 16.	16 and over.	Under 16.						16 and over.	Under 16.	16 and over.	Under 16.				
$3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	
13																	
14																	
15																	
16																	
17																	
18																	
19																	
20																	

[1] For messengers paid by the hour, day, or month (reduce all to weekly rate). If paid by the piece or message, give rates: day, ...; night, ... Number so employed, ...

Of all employees, give number working six days in the week, ...; seven days, ...
Are employees allowed one day in seven for their own use? ...... If Sunday labor is paid for extra, mention the rate per hour, ...
Rate of pay per hour for overtime, ... How many hours constitute a day's or night's work? ...... For operators, day, ...; night, ... Messengers, day, ...; night, ... Others, day, ...; night, ...
Explain method of working by shifts: ....
Does the company maintain a school of instruction to teach telegraphy? ...... Does company contribute to private school of instruction? ......

9. Number of messages sent during each year since 1890, together with average receipts per message:

Year.	Number of messages.	Average receipts.	Year.	Number of messages.	Average receipts.	Year.	Number of messages.	Average receipts.
1891		$	1895		$	1899		$
1892			1896			1900		
1893			1897			1901		
1894			1898			1902		

10. Total number of telegraph offices (including railway offices, whether operated solely, or only in part, for the business of the telegraph company): ....
Total number of telegraph offices in railway stations: ......
11. Kind of rate, if any, compulsory under law or franchise governing this company: ...... Any limit to charges? Maximum: ...... Minimum: ......
12. Construction, subways or conduits:

Kind.	Owned and used by this company.				Leased from other companies or municipality.		
	Miles of street occupied by subway or conduit.	Total miles of duct.	Total wire mileage.		Total miles of duct.	Total wire mileage.	
			Cable.	Single wire.		Cable.	Single wire.
Concrete							
Terra cotta and vitrified clay							
Iron pipe, plain or lined with cement							
Wooden duct, etc							

Miles of submarine cable, ...; miles of submarine cable circuit in wire, ...

13. Construction—overhead lines owned and operated, or leased and operated: (Including lines on railways if owned, or leased and operated, by this company.)
Miles of pole line, ... Miles of overhead single wire: Copper, ...; iron, ... Miles of overhead cable, ... Mileage of conductors in overhead cables, ... Number of miles of wire operated: Single, ...; duplex, ...; quadruplex, ...; machine or automatic, ...

14. Total wire mileage operated each year since 1890:

YEAR.	Mileage.	YEAR.	Mileage.
1891		1897	
1892		1898	
1893		1899	
1894		1900	
1895		1901	
1896		1902	

15. Pole lines leased to other telegraph companies: Number, ...; length, ...; wire mileage, ... Pole lines leased from other telegraph companies: Number, ...; length, ...; wire mileage, ... Circuit mileage of wire leased to exchanges, individuals, business companies, and press associations, ... Miles of pole line on railways: Copper, ...; iron, ... Miles of other wire on railways, if any: Copper, ...; iron, ... Wire mileage of pole line on railways: Copper, ...; iron, ... Number of railways, or railway systems (state which) embraced:..............................

16. Poles:

(1) Kind of wood: ....

(2) Sources of supply: State, ...

(3) Specifications and prices:

YEAR.	Average price per pole.	DIAMETER.		Soundness.	YEAR.	Average price per pole.	DIAMETER.		Soundness.
		Butt.	Top.				Butt.	Top.	
1891					1897	$			
1892					1898				
1893					1899				
1894					1900				
1895					1901				
1896					1902				

REMARKS.—Please give any other particulars of interest regarding specifications: ....

(4) Seasoning—manner: ....
Time required, ... Average weight of poles, seasoned, ...; unseasoned, ...

REMARKS.—Please give any further particulars of interest concerning seasoning: ....

(5) Preservative treatment: Average life of poles, treated, ...; untreated, ...
Describe process in detail: ....

17. Power plants in offices:

	Number.	Total horsepower.
Engines		
Dynamos		
Motor generators		
Number of offices using dynamo current for telegraphy.		

	Number of cells.
Batteries in offices:	
Primary batteries	
Storage batteries	

18. Capital stock, bonds, and dividends:

	Number of shares or bonds.	Total par value.	DIVIDENDS AND INTEREST.	
			Rate.	Amount.
Authorized capitalization:				
Common stock		$		$
Preferred stock				
Bonds				
Capital stock and bonds issued:				
Common stock				
Preferred stock				
Bonds				

19. Stocks and bonds authorized and issued since 1890, with dividends and interest:

YEAR.	STOCK. Authorized.	STOCK. Outstanding at end of year.	STOCK. Dividends.	YEAR.	BONDS. Authorized.	BONDS. Outstanding at end of year.	BONDS. Interest.
1891	$	$	$	1891	$	$	$
1892				1892			
1893				1893			
1894				1894			
1895				1895			
1896				1896			
1897				1897			
1898				1898			
1899				1899			
1900				1900			
1901				1901			
1902				1902			

20. Revenue and expenses:

Revenue—

Gross receipts, telegraph traffic (including traffic receipts from other companies).	$........
Dividends from other companies or other sources	....
Leased telegraph lines, wires, and conduits	....
Real estate	....
Interest	....
Miscellaneous (specify items)	....
Total	$........

Expenses—

General operation and maintenance	$........
Legal expenses	....
Rentals of offices and other real estate	....
Rentals of conduits and underground privileges	....
Telegraphic traffic (paid or due to other companies)	....
Paid or due to telephone companies for traffic	....
Miscellaneous	....
Interest on floating debt	....
Interest on funded debt, paid or accrued	....
Taxes of all descriptions	....
Paid for use of leased lines	....
Dividends paid or accrued	....
Carried to reserve	....
Carried to surplus	....
Total	$........

Cost of lines and equipment added during the year (indicate whether by purchase or construction), $..............

21. Balance sheet:

ASSETS.		LIABILITIES.	
Kind.	Amount.	Kind.	Amount.
Construction and equipment	$........	Capital stock	$........
Real estate	....	Bonds	....
Stocks and bonds of other telegraph or of telephone companies.	....	Reserves	....
Other stocks and bonds	....	Bills and accounts payable	....
Patent account	....	Dividends unpaid	....
Machinery, tools, and supplies	....	Surplus	....
Bills and accounts receivable	....	....	....
Cash and deposits	....	....	....
....	....	....	....
....	....	....	....
....	....	....	....
Total	$........	Total	$........

REMARKS.

....

....

SPECIAL SCHEDULE NO. 17.—MUNICIPAL FIRE ALARM.

Name of municipality, ...

General office; street and number, ...

State, ...

UNITED STATES CENSUS OFFICE,
Washington, D. C., April 15, 1903.

By section 7 of the act of Congress for the establishment of a permanent Census Office, approved March 6, 1902, the Director of the Census is required to prepare a report on the telegraphs and telephones of the United States, and the following schedule has been formulated for that purpose.

Municipal fire alarm telegraphs are an important feature of the development of the use of electricity, and to aid in insuring a complete presentation it is urgently requested that municipal authorities fill out and return this schedule promptly. The inquiry comprehends only police patrol and fire alarm systems operated by electricity. A return of systems otherwise operated, if any, is not required.

If fire alarm telegraph and police patrol telegraph are operated under the same supervision, separate reports should be made on special schedules Nos. 17 and 18, respectively. If this is not practicable, a full report for the entire system should be made on this schedule.

Mr. Thomas Commerford Martin, of New York city, expert special agent, is in charge of the electrical branch of this inquiry.

The information returned on this schedule should cover the year ending December 31, 1902. If this is impracticable, the year covered by the report should be the last fiscal year of the municipality. All questions that require a fixed time should be of the date of the last day of the year covered by the report.

WILLIAM R. MERRIAM,
Director of the Census.

CERTIFICATE.

This is to certify that the information contained in this schedule is complete and correct, to the best of my knowledge and belief, and it covers the period from ......, 190 , to ......, 190 .

....

(Signature and official designation of the person furnishing the information.)

1. Date when system was installed: ....
2. By what department, bureau, or board administered (give full particulars): ...
....
3. Is system owned by city? ......
4. If any part of system is leased from, or operated in connection with, a private company, give name of company, cost, and full particulars of the agreement or arrangement: ....
....
5. Are municipal fire alarm and municipal police patrol under the same supervision? ....

(If operated under the same supervision, separate reports should be made on schedules Nos. 17 and 18, respectively. If it is impracticable to separate accounts, a complete return should be made for the entire system on this schedule.)

6. Salaries and wages (electrical department only):

(For headquarters, central, and substation employees whose time is wholly occupied with the management, care, or operation of the electrical department of the fire alarm telegraphs, or the accounts thereof. The average number employed during the year is the number that would be required, at continuous employment, for the twelve months. If persons are employed at odd times to care for line, batteries, or other equipment, please explain methods of employment.)

	Average number employed during the year.	Total salaries and wages paid during the year.
General managers, superintendents, electricians, and experts	....	$........
Clerks and bookkeepers	....	....
Operators of all kinds:		
Male	....	....
Female	....	....
Foremen and inspectors	....	....
Linemen, wiremen, batterymen, etc	....	....
All other employees of electrical department exclusively	....	....

7. Character of construction:

OVERHEAD CONSTRUCTION.					UNDERGROUND CONSTRUCTION.				
Miles of pole line for wires or cables.		Total wire mileage.	Miles of single wire (other than cables).	Miles of single wire in cables.	Street miles of conduit.		Total wire mileage.	Miles of single wire (other than cables).	Miles of single wire in cables.
Owned.	Leased.				Owned.	Leased.			
....	....	....	....	....	....	....	....	....	....

If the poles or conduits are not owned by the city, does the city have perpetual right of way, without cost, covered by city ordinance? ....

8. Number and character of boxes or signaling stations:

KIND.	Total number of boxes.	Number of boxes on poles or posts.	All other boxes.
Signaling	....	....	....
Telegraphing	....	....	....
Telephoning	....	....	....
Annunciating	....	....	....

Where boxes or signaling stations are equipped with more than one form of apparatus, please so state, giving description of equipment ....

....

Number of special telephones, ...

9. Number of fire alarms of all kinds received during the year, ...

Number of police calls received or sent during the year: Telephone, ...; all other, ...

(When this schedule is used for both municipal fire alarm and police patrol, alarms and calls should be separated, as provided for in this question. When used for fire alarm only, police calls are not to be given.)

10. Central office equipment:

Manual transmitters: Number, ...; kind, ...

Automatic transmitters: Number, ...; kind, ...

Receiving registers of all kinds: Number, ...

Receiving circuits: Number, ...

Transmitting circuits: Number, ...

Telegraph switchboards: Number, ...; kind, ...; number of sections, ...; total capacity, ...

Telephone switchboards: Number, ...; kind, ...; number of sections, ...; total capacity, ...

11. Central station power equipment for signaling purposes only:

	Number.	Total horsepower.
Engines	....	....
Dynamos	....	....
Motor generators and dynamotors	....	....
		Number of cells.
Primary batteries		....
Storage batteries		....

Please give full description of any peculiar features of the fire alarm electrical service of your city: ....

....

....

SPECIAL SCHEDULE NO. 29.—RAILWAY TELEGRAPHS AND TELEPHONES.

WASHINGTON, *October 15, 1903.*

SIR: In order to comply with the requirements of section 7 of the act of Congress of March 6, 1902, providing for the collection of statistics relating to telegraph and telephone business, it is necessary that all railroad companies operating telegraph and telephone lines answer the following inquiries. It is of importance that these statistics be collected as rapidly as possible and that the reports be published at the earliest practicable date. I shall, therefore, be pleased to have your company answer the following inquiries and return this sheet at once to the Bureau of the Census in the inclosed official envelope, which requires no postage.

Very respectfully,

S. N. D. NORTH,
Director.

1. Name of railroad company or system making this report ....
2. Location of general offices: State ......, City ....
3. Names of subsidiary or consolidated companies embraced in this report.....

....

4. Did the company or system making this report operate telegraph lines during 1902 in connection with the operation of the railroad? ......
5. Did the company or system making this report operate telephone lines during 1902 in connection with the operation of the railroad? ....
6. Total number of telegraph offices ....
7. Total number of offices equipped with telephones ....
8. Total number of telegraph messages sent during year covered by report for railroad business ....
9. Total number of telephone messages sent during year covered by report for railroad business ....
10. Total number of telegraph messages sent during year covered by report for commercial business ......
11. Power plants in offices:
    a Engines............number ......; total horsepower ....
    b Dynamos..........number ......; total horsepower ....
    c Motor generators..number ......; total horsepower ....
    d Number of offices using dynamo current for telegraphy ......
    e Batteries in offices..{Primary batteries: Number of cells ....; Storage batteries: Number of cells ....}
12. Number of sets of Morse instruments ......; of other telegraph instruments ....
13. Number of telephones in use ....

....

(Name and title of official giving this information.)

APPENDIX B.

INSTRUCTIONS TO SPECIAL AGENTS.

Reports must be secured on special schedule No. 19 (Form 8-308) for all telephone companies and exchange systems thereof doing a public business that were in existence during any portion of the year ending December 31, 1902, whether owned by a company, firm, partnership, or individual, or operated as farmer cooperative or mutual rural lines.

Many farmer cooperative or mutual rural lines or companies have no exchange offices or centrals of their own, but either connect with the exchange office or central of some other company or mutually maintain and operate an exchange or central.

Where a farmer cooperative or mutual rural line connects with an exchange of another company, agents must be careful to inquire whether the data relative to such a line is included in the report of the company with which it connects, and, if not so included, a separate report must be secured.

Where several mutual farmer lines maintain and operate an exchange or central jointly, one report should be obtained for the several lines, and the names of these lines must be given.

In a number of instances companies that were doing an independent business in 1902 have since become absorbed by or merged into other companies. If in such cases the report does not include the statistics for the merged companies, they must be reported on a separate schedule or schedules.

Reports must not be secured for proposed systems or for systems not in operation during any part of the year 1902.

The schedule must be carefully prepared in conformity with the general practice of the division of manufactures in gathering statistics concerning manufactures, street railways, electric light and power plants, mines and quarries, etc. All questions must be carefully answered, and amounts reported in answer to each inquiry should be tested individually and with the totals.

All entries in the schedule must be made clearly and neatly in ink. Quantities and values must be obtained from book accounts, if such accounts are available. Each question is to be answered. If any question is found not applicable and no amounts are reported, write the word "None."

An exact answer to each item enumerated in the several questions is what is required, and is what should be given if it can be secured with a reasonable amount of labor. In all cases where the answers are estimated the amounts must be preceded by the word "Estimate."

Each agent will be furnished with a list giving the names, locations, and addresses of all companies in the territory assigned to him which were in existence during the year ending December 31, 1902. This list has been carefully prepared from information received from the telephone companies and from other sources. It may not, however, be entirely complete, and the agents therefore must be constantly on the alert to discover other companies or exchange systems that were in operation in 1902. If any are discovered the Office should be advised of the names and locations thereof, and should any be within the territory assigned the agent, he should proceed to secure returns for them in the same manner that reports are secured from exchange systems already on the lists, unless they are licensees of the American Telephone and Telegraph Company (Bell), in which case they are not to be taken, as returns for the companies controlled by this system will be secured from its central office in Boston, Mass. In forwarding the reports for unlisted exchange systems the agent must call attention to the fact that they do not appear on the official list. The agent is required to visit the different localities in the order in which they are named on the list, unless he finds that railroad connections and local conditions make a change necessary. In such cases the condition and character of the change must be stated on the agent's daily report. Reports have been secured from some of the companies by correspondence. In such cases the fact is noted on the list, and the agent should not visit the company. The agents will be notified if additional reports are received by correspondence and will be furnished with a memorandum of the corrections, if any, required for such reports.

In all cases where an annual report of the company is printed, a copy of the latest report should be secured and forwarded with the schedule. Copies should also be returned of any other printed matter that will add to the information contained in the schedule.

Agents will transmit all schedules promptly, at the close of each day if possible, to the Census Office at Washington, D. C. They are required to comply with all regulations governing fieldwork and to submit daily reports on the blanks prepared for that purpose. The names of exchange systems and companies for which returns were secured, and also of those visited but for which reports were not obtained, must appear on the report for each day. Agents must also under "Remarks," on the daily report, keep the Office advised of the probable date on which they will complete their present assignment, with mention, always, of their post office and telegraph address. The relative efficiency of each agent will be determined, in part, from these daily reports.

Give on the first page of the schedule the name of the company, firm, or individual owner, the state, city, and post office, and the address of the general office if different from that of the exchange system. Obtain also the signature and official designation of the person furnishing the information. The signature of the special agent securing the return should in every case be written on the lower left-hand corner of the schedule.

Inquiry 1.—Nature of Business.

The two inquiries, "Does company do telephone business? Telegraph business?" are asked of all telephone companies, but it is probable that only a few will be found that do both a telephone and a telegraph business. For these the answer will be "Yes" to both inquiries. Where a company does only a telephone business the answer will be "Yes" to the first and "No" to the second question. Where a company does both a telephone and a telegraph business, and the system of accounts will permit of the preparation of separate reports, such reports should be secured for the telephone and telegraph business, respectively. If separate reports can not be obtained, one report should be made on special schedule No. 19 for the entire system; but in the case of large telegraph companies doing a telephone business incidentally, the combined report should be made on special schedule No. 21, for telegraph companies.

Where a telephone system is leased to and operated by another company this fact should be stated in answer to inquiry 4 of the report for the lessee company, which should include the report of the leased system.

It is the practice of some of the telephone companies to lease or rent some of their wires for the year or other specific periods for telegraphic work, as, for example, to stock brokers, provision houses, etc. In other cases the companies may employ systems which allow the successful transmission of telegraph and telephone messages at the same time over the same wires; and it is understood that these composite circuits are on the increase. Where the company leases its wires for telegraph work the fact should be elicited and stated. And if the company is using the same wire or wires for simultaneous telegraph and telephone work the fact should be noted as fully as possible.

Inquiry 2.—Date When This Exchange System was Established.

Give the date, if obtainable, when each exchange system owned by the company began operations, which will not necessarily be the date when the present owners assumed control.

For census purposes, an exchange system is any number of exchanges owned by a company, corporation, firm, or individual, within one city, town, or village. Every telephone company must be accounted for, and a separate report made for each exchange system. The schedule covering the business of the exchange system in the city where the general office of the company is located should include answers to inquiries 3, 4, 5, 6, 21, 22, 23, and 24 for the company's entire system. If it be found impossible to secure separate reports for each exchange system, one report covering all the exchange systems of a company will be accepted.

Inquiry 3.—Date and State of Incorporation.

The year when the company owning the exchange system was incorporated should be given, and the name of the state in which it was incorporated.

Inquiry 4.—Is This Company a Combination of Other Companies?

If the company has purchased, or in any other way obtained possession of, other companies or plants which it operates, the answer should be "Yes." If not, the answer should be "No."

Inquiry 5.—States in Which Operated.

In cases where companies operate exchange systems in more than one state, the names of the states in which operated should be given in answer to this inquiry.

Inquiry 6.—Cities, Towns, and Villages in Which Operated.

If the company reported owns or operates an exchange system in more than one city, town, or village, a complete list of exchanges and toll stations should be returned with the schedule, or written under "Remarks" on last page.

It will be understood that the schedule does not require the enumeration of every station, but that the object is to enumerate every place to which telephone facilities have been extended. The toll stations will, therefore, in this sense, describe a place where the company does business, but the business is not large enough to warrant the establishment of a regular central office or exchange. The exchange or central office should be distinguished, with the number of each class, and also the toll stations, with the number of each.

Inquiry 7.—Employees, Salaries, and Wages.

This statement is required in order to obtain the number and wages for each class of employees. Account for all persons employed by the company, both in the management and in the operation of the line. The number of employees who were engaged on new construction work, and their salaries or wages, should not be included in the answer to this inquiry. The wages of such employees should show only in the amount reported for "Cost of lines, real estate, equipment, etc., added during the year," inquiry 23. Give the number of officers who receive salaries (not the number of stockholders) and the amount of their salaries for the period covered by the report. Report separately the number and wages of operators, foremen, inspectors, linemen, and other classes of employees specified. The salaries and wages should include board or rent furnished as part compensation. The average number employed during the year is the number that would have continuous employment for the twelve months. There should be no difficulty in securing this information from a company of ordinary size, but it may be that the large companies keep an itemized pay roll, the total only being carried forward from each week or month. In such cases it will be necessary either to add the pay roll of each week or month for each class of employees, or to compute the aggregate for each class, using a pay roll for a representative week, or month, as the base. Results obtained by the latter method will be accepted, and should represent the pay roll for the period covered by the report.

Inquiry 8.—Average Number of Employees at Specified Weekly Rates.

This inquiry is designed to ascertain the number of employees for each of the classes enumerated according to weekly rates of pay. The distribution should be made according to the actual rates and not based on an average. If there are weekly rates other than those specified in the schedule, enumerate them, and give the number of employees for each; also give the hour rates for overtime for each of the classes. Where the employees are paid by the hour, day, month, or year the rate of pay prevailing should be reduced to a weekly basis.

Generally speaking, the wages may be for a seven-day or a seven-night week; yet, for some employees it may be six days or nights. It is important, therefore, to give the average number working each of these kinds of weeks. This is provided for in the first line under the table. The total should agree with the total in the table, and the total of operators, etc., shown under inquiry 7. Sometimes employees are given Sunday for their own use; sometimes they are paid extra for Sunday labor (if weekly wages are based upon six days' work). These questions, as well as those referring to hours of labor per day (or night) for various classes, merit close attention. Give a clear explanation of the arrangements, if any, for working by shifts. The last page of the schedule may be used for this purpose, if necessary.

Inquiry 9.—Construction: Subways and Conduits.

Underground conduits are generally owned by the telephone companies. There are, however, a few instances in which they are owned by an underground conduit company or by the municipality. In these cases the telephone company pays for the privilege of using the ducts through which its mains and feeders are drawn. Underground conduits are usually manufactured so that when laid under the street they present several ducts to be filled with cable for carrying electricity.

"Total wire mileage in cables" means miles of single wire in cables. If a cable contains two wires running 1 mile, the wire mileage is 2. If there is 1 mile of single wire in each of four ducts the wire mileage of single wire is 4. "Miles of submarine cable" refers to length of cable laid under water across bays, harbors, rivers, and other bodies of water; and "Miles of circuit in wire," the number of miles of single wire they contain.

Inquiry 10.—Construction: Overhead Lines.

"Miles of pole line" means the number of miles in length covered by the poles on which the wire is strung, whether these lines are cables or single wires. "Miles of single wire on pole and roof line" calls for the length of all the wires (except the wire in cables) and the answer will be the wire mileage on roofs added to the wire mileage on poles with the exception of the cable wires. "Miles of overhead cables" calls for the length of cables, and "Miles of circuit in wire in overhead cables," the total length of all the wires inclosed in the cable.

Inquiry 11.—Poles.

The kind of wood, such as chestnut, cedar, Norway pine, etc., should be stated. Give the name of the state where the poles were cut. The questions under specifications and prices should be carefully answered for each year since 1890, during which the exchange system has been in existence. Manner of seasoning refers principally to whether poles are seasoned by the natural process of drying or in a dry kiln. The preservative treatment refers to the process by which the life of the pole is lengthened.

Inquiry 12.—Miles of Wire in Operation.

The total miles of wire in operation are required for each year since 1890 during which the exchange system has been in existence.

Inquiry 13.—Talks and Subscribers.

In reply to this inquiry the total number of messages or talks—originating calls—should be given, except those over private exchange wires. Long distance messages should, while included in the total, be separately reported.

The total number of messages or talks should include all toll connections and subscribers' talks, but not "service" messages, or talks by telephone officers or employees, nor free talks. The total is the whole number of messages or talks during the year covered by the report, and should be equal to the sum of the total exchange connections and the total long distance and toll connections.

A long distance connection is one between exchange systems of different companies, but this definition is subject to modification, and the practice of the companies submitting reports may be accepted.

In securing information for the schedule it will be found that a wide variation will probably exist in the application of the terms "long distance connection," "toll connection," etc., and the object is to separate or distinguish the long distance and toll connections from the regular conversations within the central office or exchange district for which no extra charge is made. This point is alluded to again in the instructions under inquiry 14, where it is explained that all talks or messages from pay stations within the same central office or exchange systems are to be counted as regular subscribers' talks, as these do not imply any exchange of business between separate companies or separate exchange systems. It will happen, however, that pay stations are very often used for long distance service, and in this event it is believed that all companies will have records bearing upon this point and giving the separate figures, enabling the separation to be made between simple exchange connections and the "extraterritorial" work.

The total number of subscribers should include subscribers of all kinds, whether having single stations or private branch exchanges, as of record for the last day of the year covered by the report.

Inquiry 14.—Toll Connections.

For census purposes, a toll connection is one between exchange systems of the same company. All talks or messages from pay stations of any kind within the same exchange system are to be treated as exchange connections.

Inquiry 15.—Is Rate Compulsory?

In some states and cities it may be found that the statute law, or an ordinance, or the charter under which the company operates, requires the company to charge a certain kind of rate, and not more than a certain sum, for use of its line.

Rates are usually divided into flat, graduated, and measured, but there may be other kinds. Some one, or all, of these may be required or permitted, and it is important to mention them with accuracy. A flat rate is a fixed sum per year. A graduated rate may be fixed for a series of years, but may vary in amount, as $40 for the first year, $30 for the second, $25 for the third, and so on to the end of the term. A measured rate is one in which the subscriber is entitled, for a certain sum, to a definite number of calls, say 600 per year. If he exceeds this number (and the record is kept in the exchange) he is charged a certain rate for each additional message or talk. In many places this is becoming the prevailing method. It is hardly likely that it will be required by law. It is probable that the flat rate will sometimes be required, with a fixed maximum, differing, perhaps, for business places and for residences, in which case required rates should be carefully noted. It is probable that in some cases compensation is required for franchise or charter, as, for instance, free telephones for municipal purposes, or use of poles or conduits for municipal wires. Such provisions should be described fully on the last page of the schedule.

Inquiry 16.—Charges for Service.

The various kinds of charges, as set forth under inquiry 15, are here provided for. Rates, flat and measured, should be given in the blanks left for that purpose, with the year when measured rates were adopted. Specify whether the rates given represent month or year. Rate cards, if in use, should always be obtained and attached to the schedule. Full explanations concerning replies to this inquiry should be given on the last page of the schedule under "Remarks."

Inquiry 17.—Farmer or Rural Lines.

The growth of farmer or rural lines, especially in the middle West and Western states is notable. The number of such lines, the wire mileage (length of all wires), and the total number of associated farmers or rural subscribers should be reported separately in answer to this inquiry. The wire mileage on such lines, when owned and operated by the company reporting, must be included in reply to construction (probably overhead)—inquiry 10—and the total number of subscribers, in reply to inquiry 13.

Many farmers have associated themselves in mutual or cooperative companies, building the circuits at their own expense, and connecting them with a regular telephone exchange system. The number and names of such lines, together with the total wire mileage, and total number of associated farmers or rural subscribers of these lines must be given by the telephone exchange system with which they are connected, the names being given on the last page of the schedule. Cooperative or mutual companies operating independently of other exchanges should be reported on separate schedules only.

In case the company reporting owns farmer or rural lines, and also has cooperative or mutual lines connecting with its exchange system, *both* should be reported in inquiry 17, but the figures for each should be given separately.

This is considered one of the interesting features of the present inquiry as bearing upon the development of a novel branch of cooperative work, and as eliciting the extent to which the telephone is modifying rural conditions. In some cases it will be found that a farmers' group is simply a network of intercommunicating telephones with several on a single wire, and probably without a central office. But these cases should be regarded as one central office or exchange system and treated accordingly, even if the network should have no outside connection with other places.

Inquiry 18.—Switchboards, Power Plants, and Batteries.

Switchboards are, as a rule, classed as "manual," that is, they are operated by the hand of the operator, who connects the jacks with the proper numbers as the calls are received. Occasionally an automatic switchboard will be found by which the subscriber, using a device attached to his telephone box, can make connection with the person with whom he desires to converse.

The number and horsepower of engines, dynamos, and motors or motor generators (for telephone service only, not for lighting or other purposes) are asked for. The horsepower of these machines is easily ascertainable, being usually found on the name plate of the machine itself; if not, the engineer or electrician should be able to give it of his own knowledge. Electric motors are often known, in this connection, as motor generators. They are used to convert the current to a lower or higher voltage. This current is sometimes put directly on the wire from the motor; sometimes it is fed into storage batteries, from which it is used as occasion requires. Motors may be used under both local and central energy, or common battery systems; in the former case, they are used only to enable the operators to ring up subscribers without the use at the switchboard of a magneto-generator; in the latter, not only for this, but to furnish the current, either directly or from storage batteries, for the conversational use of the wires.

The number of switchboards operated by the common battery systems and the number by the magneto system are required to be given. A common battery is often called "central energy." It is a battery, either storage or primary, located at the exchange for operating all the subscribers' stations. In a magneto system a primary battery is at each telephone station or box. This furnishes the current for conversation; the current for the ringing up of central is created by a magneto-generator attached to the telephone. The subscriber, by turning a little crank, sets the electro-magnet revolving, and thus sends in his signal. Under the common battery system the removal of the receiver from its hook closes a circuit and lights a lamp or operates a drop at the distant switchboard in the exchange.

The number of magneto-generators, ringers, etc., is required. This is the number at exchanges, not those attached to subscribers' telephones.

The total capacity for which switchboards are equipped is the number, not only of subscribers already accommodated, but of those that, with existing equipment, may be connected. Auxiliary cross-connection boards and distributing boards should not be confounded with switchboards. Auxiliary cross-connection boards are those to which, in some large exchanges, wires are trunked out or connected with outlying exchanges that are very much in demand. Distributing frames are the main distributing frames by which the wires are received into the exchange from the conduits or otherwise and distributed to the operating rooms. Tester boards, by which the wires are tested for defects when complaints are made, may be attached to them. But there are also auxiliary distributing frames in operating rooms; these should be included. Through them the wires are distributed to the switchboards.

The number of cells of batteries is the number of jars. Primary batteries generate electricity by the action of acids upon metallic plates (the ordinary method); storage batteries are those in which electricity is stored by means of an electric current.

An engine, dynamo, and motor generator—or a motor generator only (sometimes a motor generator may be called a motor only)—may correctly appear in a schedule without either storage or primary batteries, but this will seldom be the case. Storage batteries may appear without engine, dynamos, or motor generator, for the electric current may be furnished by an electric lighting or power company. If there is a magneto switchboard, there must be magneto-generators, ringers, etc.

Inquiry 19.—Exchanges and Stations.

A public exchange is a place where wires are interconnected by means of a switchboard for the use of the public generally. The number of these is called for. Public branch offices are also to be included with public exchanges. A private branch exchange is an exchange office within a business building, apartment house, hotel, etc.—sometimes in a residence—through which wires running from one building or department or office or room to another are connected by a switchboard, thus establishing interior communication. Conversation with the outside world through the private exchange is had by connection with the public exchange. The number of these private exchanges should be given by the company owning them, each trunk line being counted as a subscriber. The object in counting a trunk as a subscriber is that it is believed to be the invariable practice to charge for each additional trunk, the trunk being the basis of charge by the telephone company rather than the fact that the subscriber has a private exchange connected with central.

It should be noted, however, that the use of the word "exchange" is more particularly a practice limited to the Bell system. With the independent telephonists—i. e., those who are not operating as licensees of the American Telephone and Telegraph Company, which is the parent company of the Bell system—it is quite a common practice to call the exchange a central office, and to use this phrase to the entire exclusion of the word exchange. The function of the two is, however, identical, the exchange being a central office and the central office being an exchange. Branch central offices should also be included in the same way as public branch exchanges, their functions being identical. It will be found that both among Bell telephonists and independents the exchange, or central office, is colloquially called "central," this being also the descriptive epithet used by subscribers.

The number of automatic or nickel-in-slot pay stations (which include all in which coins of any denomination, or tokens, are deposited) is to be entered separately; likewise the number of other pay stations. In entering the number of stations (or boxes or telephones) of all kinds those attached to private branch exchanges, as well as those connected with public exchanges, should be taken into account.

The total number of party lines is also called for. A party line is defined as one having two stations or more upon one circuit. In this case, as in others, the company definition of party line should be accepted. The total number of stations on party lines is also required.

Inquiry 20.—Total Stations (Boxes or Telephones).

The total number of stations (boxes or telephones) of all kinds in operation at the end of each year since 1890 (or for each year since the establishment of the exchange system) is required.

Inquiry 21.—Capital Stock, Bonds, and Dividends.

Only the capital stock and bonds authorized or issued for the establishment by the company of a telephone business should be included here, unless the system of accounting is such that a separation can not be made, in which case one report on special schedule No. 19 must be prepared, as set forth in instructions under inquiry 1.

Account for the entire amount of stock and bonds authorized and the amount outstanding at the end of the year covered by the report. Give full amount of dividends declared during the year. In some cases companies have been reorganized or consolidated and the new company has issued stock, the new stock being accepted by the holders of the original stock, which was surrendered to the new company. The new company may also issue bonds and assume the debt represented by the bonds of the original companies, which may or may not be retired. In such cases there may be no cash realized on either the stocks or bonds of the new company, but the amount of stocks and bonds issued by the new company, and also the amount of the stocks and bonds of the original company outstanding, must be given, and the agent should attach a memorandum to the schedule giving a full explanation of the issues of both stocks and bonds. The amounts for the old and new companies should be given separately.

Inquiry 22.—Stocks and Bonds Since 1890.

The amount of all stocks and bonds outstanding at the end of each year, and the total amount of dividends declared each year since 1890 (or for such number of years as the company has been in existence), are to be given in answer to this inquiry.

Inquiry 23.—Revenue and Expenses.

This is what is known as an income account, not a cash statement, and is intended to show the earnings and receipts of the company for one year.

Revenue.—The items under the head of "Revenue" generally explain themselves. "Gross receipts from telephone business" means total receipts for the use of telephones—subscribers' (including those having private branch exchanges) pay stations of all kinds, also gross receipts either for messages sent or received. "Dividends from other companies or other sources" should include all dividends received on stock owned by the company in other companies, whether such companies do a telephone or any other kind of business. The amount received for the leasing of telephone lines and wires and conduits should be given in answer to the next subquestion. If instruments are rented with these leased lines—which may be a system—or with the wires—which may include a single wire—receipts for such should be included under this head. Sometimes conduits may be leased, in part, to another telephone company or to a city or to an electric light company. The receipts for this rental should be placed in this item. "Real estate" covers receipts from rental of offices, buildings, or land, and "Interest" amounts received as interest on money loaned. It is possible that some companies have a separate messenger service and that an independent revenue is derived from that source. This and all receipts from sources other than those enumerated should be included under "Miscellaneous." The items should be specified.

Expenses.—All payments for the general operation of the company and the maintenance of the lines and business, except as indicated in the subquestions following, are to be placed opposite the first subquestion. This item should also include, among other things, salaries of all kinds, whether administrative or otherwise (except salaries that may be paid for legal services, which are provided for in "Legal expenses"), and wages of all kinds, and the supplies of all kinds (wire, telephones, etc.), consumed during the year, etc. Expenses and wages incident to new construction should not be included. Legal expenses should include everything paid in settlement of claims for damages, law charges, and counsel fees, of whatever kind, whether for securing franchises, for reorganization, for funding processes, for securing right of way, etc. Interest is divided into interest on floating debt and interest on funded debt as bonds. Taxes of all descriptions should include taxes on real estate, franchise, licenses, wire mileage, gross receipts, etc. "Telephone traffic paid to other companies" means toll paid to other companies for the transmission of messages or talks. The amount reported as "Carried to reserve" should include the amount set aside for sinking fund to meet bonds and notes, etc., or for the purpose of providing against depreciation of plant or to create an insurance fund.

Below the total expenditures is a question concerning the cost of lines, real estate, equipment, etc., added during the year, whether by purchase or construction. The amount reported for this question should not be included in any of the expense items. The term "lines" is intended to include all things necessary to complete a system for operation—poles, wires, conduits, terminal buildings, offices, etc., and all attachments not included in "equipment." "Equipment" consists of the power house plant, engines, dynamos, motor generators, batteries, switchboards, distributing frames, arrester boards, telephones of all kinds, telephone cabinets, desks, etc., and all else not included in "lines." The total expenditure for extensions during the year must be given in answer to this inquiry and should also be included in the amounts reported for the first three items under "Assets," inquiry 24.

In all this revenue and expenditure showing the statements as given by the companies ought to be accepted as correct, unless they are grossly inconsistent, containing irreconcilable statements. In such cases, after the agent or examiner has grounded himself in the subject so that he can make a clear statement from his own point of view, a friendly suggestion of apparent inconsistencies will generally clear up the difficulties and lead to corrections, if such are necessary.

Inquiry 24.—Balance Sheet.

The first item of assets called for is intended to include the value (cost) of construction and equipment (not including telephone instruments). While this item should not include telephone instruments, it ought to include telephone cabinets, desks, supplies, etc., if owned, either in use or on hand at the close of the year.

The value (cost) of telephone instruments (if owned) is called for separately, both those in use and such as are on hand and not in use. The other items called for are self-explanatory. All these are to be given at the value carried on the books of the company at the end of the year covered by the report.

In cases of unincorporated companies, individuals, firms, etc., which have no liabilities of capital stock and bonds the amount of cash invested should be entered under "Liabilities" to balance the "Cost of construction, equipment, etc.," of the "Assets." This amount should be written on one of the blank lines below "Surplus" and not shown opposite any of the items.

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