CHAPTER IV.

POWER EMPLOYED IN MANUFACTURES.

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I.

GENERAL SUMMARY.

The aggregate motive power employed in manufacturing establishments in the United States during the census year was 11,300,081 horsepower, as compared with 5,954,655 horsepower in 1890, 3,410,837 horsepower in 1880, and 2,346,142 horsepower in 1870. The increase from 1890 to 1900 was 5,345,426 horsepower, or 89.8 per cent; from 1880 to 1890, 2,543,818 horsepower, or 74.6 per cent; and from 1870 to 1880, 1,064,695 horsepower, or 45.4 per cent.

Of the total power used in manufactures during the census year, steam engines furnished 8,742,416 horsepower, or 77.4 per cent of the aggregate; water wheels supplied 1,727,258 horsepower, or 15.3 per cent; electric motors, 311,016 horsepower, or 2.7 per cent; gas and gasoline engines, 143,850 horsepower, or 1.3 per cent; and other forms of mechanical power 54,490 horsepower, or five-tenths of 1 per cent. In addition to the above power, which was generated by the establishments by which it was used, rented power was used to the extent of 321,051 horsepower, or 2.8 per cent of the total. Of this rented power 183,682 horsepower was electric, and 137,369 horsepower was other power.

The statistics embraced by this report relate only to power used in manufacturing operations, and do not include any portion of the vast amount of power that is used for other purposes. These figures, therefore, do not by any means represent the total use of power in the United States. In fact, the rapidly increasing application of power to other industrial uses than manufacturing has steadily reduced the ratio of power used for driving machinery in mills and factories to the total power applied to all uses. This condition was even more marked at the Twelfth Census than when the Eleventh Census was compiled; and it is no longer safe to take the power employed in manufacturing as a basis upon which to make calculations concerning the aggregate power requirements of the country.

A few decades ago the use of power in any considerable quantity was limited practically to manufacturing operations. Within the past twenty years, and more particularly during the last decade, the use of electricity for lighting and for the operation of street railways has developed enormously, and has resulted in the utilization of power in an entirely new field to an extent that exceeds the total amount of power used in many of the larger manufacturing industries.

During 1900 over 1,200 electric railway lines were in operation in the United States, and the total capacity of their power plants exceeded 1,000,000 horsepower. There are over 3,300 central stations for the distribution of electric current for lighting and power purposes, and the total amount of steam power used to generate it is estimated to be more than 1,500,000 horsepower. One company alone, in New York city, operates several central stations, aggregating nearly 250,000 horsepower. Independent isolated electrical plants, which furnish light and power for stores, office buildings, hotels, public buildings, etc., constitute another item of power of great magnitude. There are no data available for even approximating the amount of power thus utilized in the entire United States;[1] but a recent canvass of New York city by one of the electrical companies showed that the isolated electrical plants in that city represented over 100,000 horsepower thus applied.

The modern office building, often housing a population equal to that of a small town, is almost wholly a creation of the past ten years, and the power required in these great structures, not only for lighting purposes, but for the operation of elevators, pumping water, compressing air, and operating refrigerating and ventilating machinery, forms a large item when the number of these buildings in the United States is taken into consideration.

As illustrative of this, the power plant of one sixteen-story modern building, containing 560 offices, may be of interest. In this building there are 4 engines, 3 of 150 horsepower each, and 1 of 75 horsepower, which are used to drive dynamos. Four small engines connected to ventilating fans represent about 50 horsepower. For the hydraulic elevator service there are 5 pumps, 1 of about 150 horsepower, 1 of 105 horsepower, 1 of

[1] This subject is one of the special investigations about to be made by the permanent census office.

100 horsepower, and 2 of 40 horsepower each. Altogether, the engines and pumps in this one office building represent an aggregate of about 1,000 horsepower. A considerable part of this equipment is duplicate machinery, provided for emergencies, but not less than 700 horsepower is used continuously in the building. From this may be judged the importance of this use of power, which has developed almost entirely since 1890.

The use of steam power, either directly applied or electrically transformed and transmitted, is becoming more and more general in mining and quarrying, in public works of every description, in the sinking of foundations, in the erection of buildings, and in nearly every branch of industry, and the amount of power used, apart from manufacturing operations, is increasing steadily.

The application of power to diversified operations, as indicated above, has been most noteworthy during the past ten years; and it is easy to see, even without any definite statistical presentation, that while the power used in manufacturing in 1890 probably embraced by far the largest part of the motive power applied to all purposes, similar figures for 1900 represent a much smaller proportion of all the power used in the United States.

Comparisons of the power statistics of different censuses are not strictly accurate, owing to the variation in the scope of the inquiries in each census year. For example, cotton ginning, which in the aggregate requires a very considerable amount of power, was not included in the statistics of manufactures in 1870 and 1880, but was included in 1890 and 1900.

The power used in the generation of electricity in the state of New York, the city of St. Louis, Mo., and the District of Columbia was included in the statistics for 1890, but no corresponding figures are contained in the compilations for previous years or for 1900. The inclusion of certain industries at some of the censuses and their omission at others tends still further to impair the accuracy of any comparisons that may be drawn between the power statistics for different census years. These variations and apparent discrepancies, however, form such a small percentage of the aggregate power used in manufactures that for all practical purposes they need not be considered.

II.

COMPARATIVE STATISTICS.

Table I is a summary of the statistics of power for the United States as returned at the censuses of 1870 to 1900, inclusive, with the percentages of increase for each decade.

TABLE I.—COMPARATIVE SUMMARY, 1870 TO 1900, WITH PER CENT OF INCREASE FOR EACH DECADE.

	DATE OF CENSUS.				PER CENT OF INCREASE.		
	1900	1890	1880	1870	1890 to 1900.	1880 to 1890.	1870 to 1880.
Total number of establishments	512,254	355,415	253,852	252,148	44.1	40.0	0.7
Total number of establishments reporting power	169,409	100,735	85,923	(1)	68.2	17.2	.....
Per cent of establishments reporting power to total number	33.1	28.3	33.8	.....	.....	.....	.....
Total horsepower	11,300,081	5,954,655	3,410,887	2,346,142	89.8	74.6	45.4
Average horsepower per establishment	66.7	59.1	39.7	[2] 9.3	12.9	48.9	326.9
Steam engines—							
Number	156,100	91,410	56,483	(1)	70.8	61.8	.....
Horsepower	8,742,416	4,581,595	2,185,458	1,215,711	90.9	109.7	79.8
Per cent of total horsepower	77.4	76.9	64.1	51.8	.....	.....	.....
Gas engines—							
Number	14,884	(1)	(1)	(1)	.....	.....	.....
Horsepower	143,850	8,930	(1)	(1)	1,510.9	.....	.....
Per cent of total horsepower	1.3	0.1	.....	.....	.....	.....	.....
Water wheels—							
Number	39,182	39,008	55,404	(1)	0.4	[3] 29.6	.....
Horsepower	1,727,258	1,255,206	1,225,379	1,180,431	37.6	2.4	8.4
Per cent of total horsepower	15.3	21.1	35.9	48.2	.....	.....	.....
Electric motors—							
Number	16,923	(1)	(1)	(1)	.....	.....	.....
Horsepower	311,016	15,569	(1)	(1)	1,897.7	.....	.....
Per cent of total horsepower	2.7	0.3	.....	.....	.....	.....	.....
Other power—							
Number	2,144	(1)	(1)	(1)	.....	.....	.....
Horsepower	54,490	4,784	(1)	(1)	1,039.0	.....	.....
Per cent of total horsepower	0.5	0.1	.....	.....	.....	.....	.....
Total rented horsepower	321,051	88,571	(1)	(1)	262.5	.....	.....
Per cent of total horsepower	2.8	1.5	.....	.....	.....	.....	.....
Electric rented horsepower	183,682	[4]	(1)	(1)	.....	.....	.....
All other rented horsepower	137,369	[4]	(1)	(1)	.....	.....	.....

[1] Not reported. [2] Average for all establishments. [3] Decrease. [4] Not reported separately.

In view of the generally prevailing belief that mechanical power has been and still is very largely supplanting hand labor in almost every branch of industry, it may appear strange that with an increase of 101.8 per cent in the total number of manufacturing establishments between 1880 and 1900, and with an increase of 142.2 per cent in the total value of products during the same interval, the proportion of manufacturing establishments reporting the use of power was the same in 1900 as in 1880—about one-third. In 1880 the use of power was reported by 85,923 out of 253,852 establishments, or 33.8 per cent. In 1890, 100,735 out of a total of 355,415 establishments reported the use of power, or 28.3 per cent of the aggregate. The reduced proportion was doubtless due to the more thorough canvass and the consequent inclusion of a larger number of small plants. In 1900 the proportion of establishments using power increased again to 33.1 per cent, or 169,409 out of a total of 512,254.

This indicates that while the substitution of power-driven machinery for hand labor has unquestionably taken place to a very great extent—which can be demonstrated by a study of many branches of manufacture—at the same time the increase of hand-labor shops and small factories using some machinery but no mechanical power has also been continuous, with the result that at the present time the numerical proportion of manufacturing establishments operating without any mechanical power is as large as it was twenty years ago.

How small a proportion the products of this class of establishments are of the total value of manufactured products for all industries is shown by the fact that the group of industries classed as "hand trades" in 1900, contributed only $1,183,615,478 to the total of $13,004,400,143, the value of the products of all manufacturing industries. Although there were 215,814 establishments classified as "hand trades" out of a total of 512,254, or 42.1 per cent, the value of the products of such establishments was only 9.1 per cent of the total for all establishments. The classification of "hand trades," however, does not embrace all establishments operating without mechanical power, nor do all establishments otherwise classified use power, but this illustration suffices to show the minor importance of the industries which do not use power, as compared with those that use power in some form.

Table II shows the average horsepower per establishment for 11 of the principal industries for 1880, 1890, and 1900.

TABLE II.—*Average horsepower per establishment in selected industries: 1880 to 1900.*

INDUSTRIES.	AVERAGE HORSEPOWER PER ESTABLISHMENT.		
	1900	1890	1880
All industries	66.7	59.1	39.7
Agricultural implements	129.7	66.3	34.9
Boots and shoes, factory product	39.7	22.5	15.6
Cotton goods	840.4	527.1	288.2
Flouring and grist mill products	42.1	41.0	31.8
Hosiery and knit goods	69.8	58.9	51.2
Iron and steel	2,503.3	1,156.3	503.6
Lumber and timber products	50.9	49.6	32.0
Paper and wood pulp	1,002.4	471.1	179.1
Silk and silk goods	129.3	77.2	44.7
Woolen goods	186.4	99.2	53.7
Worsted goods	526.4	410.9	216.3
All other industries	46.3	42.7	28.3

The average horsepower per establishment as presented in table II is the average of the establishments using power as shown for the several industries in General Table 12, page 596.

The increasing importance of the larger plants is manifest in the continuous increase in the average of power per establishment. In 1880 the average power of the establishments which reported its use was 39.7 horsepower; in 1890 it was 59.1 horsepower; and in 1900 it was 66.7 horsepower. There was, therefore, in the twenty years from 1880 to 1900 an increase in the average power per establishment of 27 horsepower, or 68 per cent.

III.

STEAM POWER.

Table III shows the amount of steam power used by states and territories as returned at the censuses of 1870 to 1900, inclusive, with the amount and percentage of increase for each decade.

TABLE III.—STEAM POWER USED IN MANUFACTURE, BY STATES AND TERRITORIES, 1870 TO 1900, WITH THE AMOUNT AND PER CENT OF INCREASE FOR EACH DECADE.

STATES AND TERRITORIES.	HORSEPOWER.				INCREASE.					
	1900	1890	1880	1870	1890 to 1900.		1880 to 1890.		1870 to 1880.	
					Amount.	Per cent.	Amount.	Per cent.	Amount.	Per cent.
United States	8,742,416	4,662,029	2,185,458	1,215,711	4,080,387	87.5	2,476,571	113.3	969,747	79.8
Alabama	199,220	91,805	15,779	7,740	107,415	117.0	76,026	481.8	8,039	103.9
Alaska	1,078	290	.....	.....	788	271.7	290	.....	.....	.....
Arizona	7,688	497	370	80	7,191	1,446.9	127	34.3	290	362.5
Arkansas	116,291	36,525	13,709	6,101	79,766	218.4	22,816	166.4	7,608	124.7
California	105,857	67,426	28,071	18,493	38,431	57.0	39,355	140.2	9,578	51.8
Colorado	40,299	30,900	3,953	1,433	9,399	30.4	26,947	681.7	2,520	175.9
Connecticut	178,708	98,038	57,027	25,979	80,670	82.3	41,011	71.9	31,048	119.5
Dakota	[1]	[1]	1,421	248	.....	.....	6,047	425.6	1,173	473.0
Delaware	33,100	21,660	10,643	4,313	11,440	52.8	11,017	103.5	6,330	146.8
District of Columbia	8,630	10,473	2,263	789	[2]1,843	[2]17.6	8,210	362.8	1,474	186.8
Florida	38,267	15,492	6,208	3,172	22,775	147.0	9,284	149.6	3,036	95.7
Georgia	144,855	55,529	21,102	10,826	89,326	160.9	34,427	163.2	10,276	94.9
Idaho	4,506	972	546	311	3,534	363.6	426	78.0	235	75.6
Illinois	524,555	268,486	126,843	73,091	256,069	95.4	141,643	111.7	53,752	73.5
Indiana	314,776	174,060	109,960	76,851	140,716	80.8	64,100	58.3	33,109	43.1
Indian Territory	12,332	349	.....	.....	11,983	3,433.5	349	.....	.....	.....
Iowa	100,606	64,860	33,858	25,298	35,746	55.1	31,002	91.6	8,560	33.8
Kansas	57,735	34,882	13,468	6,360	22,853	65.5	21,414	159.0	7,108	111.8
Kentucky	150,328	75,836	45,917	31,928	74,492	98.2	29,919	65.2	13,989	43.8
Louisiana	213,545	29,446	11,256	24,924	184,099	625.2	18,190	161.6	[2]13,668	[2]54.8
Maine	99,751	43,748	20,759	9,465	47,003	107.4	22,989	110.7	11,294	119.3
Maryland	118,482	57,524	33,216	13,961	60,958	106.0	24,308	73.2	19,255	137.9
Massachusetts	579,110	355,226	171,397	78,502	223,884	63.0	183,829	107.3	92,895	118.3
Michigan	332,598	216,536	130,352	70,956	116,062	53.6	86,184	66.1	59,396	83.7
Minnesota	152,451	84,925	25,191	7,085	67,526	79.5	59,734	237.1	18,106	255.6
Mississippi	119,770	32,551	15,001	10,019	87,219	267.9	17,550	117.0	4,982	49.7
Missouri	191,558	139,189	72,587	48,418	52,369	37.6	66,602	91.8	24,169	49.9
Montana	29,374	2,122	544	822	27,252	1,284.3	1,578	290.1	[2]278	[2]33.8
Nebraska	31,916	17,196	2,999	1,865	14,720	85.6	14,197	473.4	1,134	60.8
Nevada	656	318	608	6,007	338	106.3	[2]290	[2]47.7	[2]5,399	[2]89.9
New Hampshire	91,541	47,652	18,595	8,787	43,889	92.1	29,057	156.3	9,808	111.6
New Jersey	283,393	162,178	72,792	32,307	121,215	74.7	89,386	122.8	40,485	125.3
New Mexico	3,579	1,502	427	252	2,077	138.3	1,075	251.8	175	69.4
New York	677,219	537,447	284,795	126,107	139,772	26.0	302,652	128.9	108,688	86.1
North Carolina	141,798	41,253	15,025	6,941	100,545	243.7	26,228	174.6	8,084	116.5
North Dakota	6,680	3,012	[3]	[3]	3,668	121.8	.....	.....	.....	.....
Ohio	758,743	387,840	222,502	129,577	370,903	95.6	165,338	74.3	92,925	71.7
Oklahoma	9,020	161	.....	.....	8,859	5,502.5	161	.....	.....	.....
Oregon	38,956	22,781	4,334	2,471	16,225	71.4	18,397	424.5	1,863	75.4
Pennsylvania	1,611,815	900,862	402,132	221,986	710,953	78.9	498,730	124.0	180,196	81.2
Rhode Island	115,876	85,327	41,335	23,546	30,549	35.8	43,992	106.4	17,789	75.6
South Carolina	100,971	29,117	11,995	4,537	71,854	246.8	17,122	142.7	7,458	164.4
South Dakota	9,443	4,456	[3]	[3]	4,987	111.9	.....	.....	.....	.....
Tennessee	141,045	68,728	33,388	18,467	72,317	105.2	35,340	105.9	14,921	80.8
Texas	231,345	65,515	28,026	11,214	165,830	253.1	37,489	133.8	16,812	149.9
Utah	8,039	2,562	1,154	331	5,477	213.8	1,408	122.0	823	248.6
Vermont	45,142	24,048	11,088	6,425	21,094	87.7	12,960	116.9	4,663	72.6
Virginia	117,267	45,590	19,710	8,410	71,677	157.2	25,880	131.3	11,300	134.4
Washington	78,066	37,675	3,210	1,411	40,391	107.2	34,465	1,073.7	1,799	127.5
West Virginia	95,595	44,755	28,456	17,136	50,840	113.6	16,299	57.3	11,320	66.1
Wisconsin	274,355	121,149	60,729	30,509	153,206	126.5	60,420	99.5	30,220	99.1
Wyoming	3,486	1,608	717	310	1,878	116.8	891	124.3	407	131.3

[1] See North Dakota and South Dakota.

[2] Decrease.

[3] See Dakota.

Steam still continues to be preeminently the primary power of greatest importance, and the census returns indicate that the proportion of steam to the total of all powers has increased very largely in the past thirty years. In 1870 steam furnished 1,215,711 horsepower, or 51.8 per cent of a total of 2,346,142; in 1880 the amount of steam power used was 2,185,458 horsepower out of a total of 3,410,837, or 64.1 per cent; in 1890, out of an aggregate of 5,954,655 horsepower, 4,581,595, or 76.9 per cent, was steam; while in 1900 steam figured to the extent of 8,742,416 horsepower, or 77.4 per cent, in a total of 11,300,081. This increase in thirty years, from 51.8 per cent to 77.4 per cent, of the total power shows how much more rapidly the use of steam power has increased than other primary sources of power.

The tendency toward larger units in the use of steam power is shown inadequately by the increase in the average horsepower per engine from 39 horsepower in 1880, to 51 horsepower in 1890, and 56 horsepower in 1900.

The tendency toward great operations, which has been such a conspicuous feature of industrial progress during the past ten years, has shown itself strikingly in the use of units of larger capacity in nearly every form of machinery, and nowhere has this tendency been more marked than in the motive power by which the machinery is driven. At the same time there has been an increase in the use of small units, which tends to distort the true tendency in steam engineering in these statistics. For example, a steam plant consisting of one or more units of several thousand horsepower may also embrace a number of small engines of only a few horsepower each, the use of which is necessitated by the magnitude of the plant, for the operation of mechanical stokers, the driving of draft fans, coal and ash conveyors, and other work requiring power in small units. On this account the average horsepower of steam engines in use at different census periods fails to afford a true basis for measuring progress toward larger units during the past ten years.

Developments of the past few years in the distribution of power by the use of electric motors have served to accelerate the tendency toward larger steam units and the elimination of small engines in large plants and to change completely the conditions just described. For example: In one of the largest power plants in the world, which is now being installed, all the stokers, blowers, conveyors, and other auxiliary machinery are to be driven by electric motors. Such rapidly changing conditions tend to invalidate any comparisons of statistical averages deduced from figures for periods even but a few years apart.

Comparison of two important industries will illustrate the foregoing. The average horsepower of the steam engine used in the cotton mills of the United States in 1890 was 198, and in 1900 it was 300. In the iron and steel industry the average horsepower per engine in 1890 was 171, and in 1900 it was 235. In the cotton mills the use of single large units of motive power, with few auxiliary engines of small capacity, gives the largest horsepower per engine of any industry; while in the iron and steel industry the average of the motive power proper, although probably larger than in the manufacture of cotton goods, is reduced by the large number of small engines which are used for auxiliary purposes in every iron and steel plant.

IV.

GAS POWER.

As shown by table 1, the decade between 1890 and 1900 has been a period of marked development in the use of gas engines, using that term to denote all forms of internal combustion engines, in which the propelling force is the explosion of gaseous or vaporous fuel in direct contact with a piston within a closed cylinder. This group embraces those engines using ordinary illuminating gas, natural gas, and gas made in special producers installed as a part of the power plant, and also vaporized gasoline or kerosene. This form of power appears for the first time as an item of consequence in the returns of the present census, and the very large increase in the horsepower in 1900 as compared with 1890 indicates the growing popularity of this class of motive power.

In 1890 the number of gas engines in use in manufacturing plants was not reported, but their total power amounted to only 8,930 horsepower, or one-tenth of 1 per cent of the total power utilized in manufacturing operations. In 1900, however, 14,884 gas engines were reported, with a total of 143,850 horsepower, or 1.3 per cent of the total power used for manufacturing purposes. This increase from 8,930 horsepower to 143,850 horsepower, a gain of 134,920 horsepower, is proportionately the largest increase in any form of primary power shown by a comparison of the figures of the Eleventh and Twelfth censuses, amounting to 1,510.9 per cent.

Within the past decade, and more particularly during the past five years, there has been a marked increase in the use of this power in industrial establishments for driving machinery, for generating electricity, and for other kindred uses. At the same time, internal combustion engines have increased in popularity for uses apart from manufacturing, and the amount of this kind of power in use for all purposes in 1900 was, doubtless, very much larger than indicated by the figures relating to manufacturing plants alone.

The average horsepower per gas engine in 1900 was 9.7 horsepower. There are no available statistics upon which to base a comparison of this average with the average for 1890, but it is doubtful if there has been any very material change in ten years; for while gas engines are built in much larger sizes than ever before, there has

been also a great increase in the number of small engines for various purposes.

The large increase in the use of internal combustion engines has been due to the rapid improvements that have been made in them, their increased efficiency and economy, their decreased cost, and the wider range of adaptability that has been made practicable.

V.

WATERPOWER.

Table IV shows the amount of waterpower used by states and territories, as returned at the censuses of 1870 to 1900, inclusive, with the amount and percentage of increase for each decade.

TABLE IV.—WATERPOWER USED IN MANUFACTURES, BY STATES AND TERRITORIES, 1870 TO 1900, WITH THE AMOUNT AND PER CENT OF INCREASE FOR EACH DECADE.

STATES AND TERRITORIES.	HORSEPOWER.				INCREASE.					
	1900	1890	1880	1870	1890 to 1900.		1880 to 1890.		1870 to 1880.	
					Amount.	Per cent.	Amount.	Per cent.	Amount.	Per cent.
United States	1,727,258	1,263,343	1,225,379	1,130,431	463,915	36.7	37,964	3.1	94,948	8.4
Alabama	21,293	10,443	11,797	11,011	10,850	103.9	[1]1,354	[1]11.5	786	7.1
Alaska	597	161	.....	.....	436	270.8	161	.....	.....	.....
Arizona	442	329	160	10	113	34.4	169	105.6	150	1,500.0
Arkansas	2,940	1,778	2,024	1,545	1,162	65.4	[1]246	[1]12.2	479	31.0
California	5,164	5,122	4,850	6,877	42	0.8	272	5.6	[1]2,027	[1]29.5
Colorado	1,596	1,740	1,849	792	[1]144	[1]8.3	[1]109	[1]5.9	1,057	133.5
Connecticut	71,414	64,655	61,205	54,395	6,759	10.5	3,450	5.6	6,810	12.5
Dakota	([2])	([2])	803	76	.....	.....	789	98.3	727	956.6
Delaware	6,326	4,671	4,785	4,220	1,655	35.4	[1]114	[1]2.4	565	13.4
District of Columbia	369	810	880	1,100	[1]441	[1]54.4	[1]70	[1]8.0	[1]220	[1]20.0
Florida	1,102	496	939	528	606	122.2	[1]443	[1]47.2	411	77.8
Georgia	40,837	28,390	30,067	27,417	12,447	43.8	[1]1,677	[1]5.6	2,650	9.7
Idaho	1,942	1,024	1,136	295	918	89.7	[1]112	[1]9.9	841	285.1
Illinois	13,175	16,124	17,445	12,953	[1]2,949	[1]18.3	[1]1,321	[1]7.6	4,492	34.7
Indiana	15,510	16,305	21,810	23,518	[1]795	[1]4.9	[1]5,505	[1]25.2	[1]1,708	[1]7.3
Indian Territory	303	75	.....	.....	228	304.0	75	.....	.....	.....
Iowa	12,159	12,645	20,363	14,249	[1]486	[1]3.8	[1]7,718	[1]37.9	6,114	42.9
Kansas	8,820	7,764	7,611	1,789	1,056	13.6	153	2.0	5,822	325.4
Kentucky	9,284	6,272	9,012	7,640	3,012	48.0	[1]2,740	[1]30.4	1,372	18.0
Louisiana	383	66	90	142	317	480.3	[1]24	[1]26.7	[1]52	[1]36.6
Maine	167,264	106,520	79,717	70,108	60,744	57.0	26,803	33.6	9,609	13.7
Maryland	13,778	15,633	18,043	18,461	[1]1,855	[1]11.8	[1]2,410	[1]13.4	[1]418	[1]2.3
Massachusetts	187,848	159,787	138,362	105,854	28,061	17.6	21,425	15.5	32,508	30.7
Michigan	42,888	39,181	34,395	34,395	3,707	9.5	4,786	13.9	[1]500	[1]1.4
Minnesota	26,953	27,404	28,689	13,054	[1]451	[1]1.7	[1]1,285	[1]4.5	15,635	119.8
Mississippi	3,437	2,752	3,449	2,453	685	24.9	[1]697	[1]20.2	996	40.6
Missouri	6,748	4,758	8,162	6,644	1,990	41.8	[1]3,404	[1]41.7	1,518	22.9
Montana	9,965	666	954	795	9,299	1,396.3	[1]288	[1]30.2	159	20.0
Nebraska	8,943	6,127	5,495	1,446	2,816	46.0	632	11.5	4,049	280.0
Nevada	929	6	108	2,538	923	15,383.3	[1]102	[1]94.4	[1]2,430	[1]95.7
New Hamsphire	112,755	69,033	69,155	68,291	43,722	63.3	[1]122	[1]0.2	864	1.3
New Jersey	24,959	17,645	27,066	25,832	7,314	41.5	[1]9,421	[1]34.8	1,234	4.8
New Mexico	559	323	932	659	236	73.1	[1]609	[1]65.3	273	41.4
New York	368,456	233,795	219,343	208,256	134,661	57.6	14,447	6.6	11,092	5.3
North Carolina	57,027	31,817	30,063	26,211	25 210	79.2	1,754	5.8	3,852	14.7
North Dakota	581	540	([3])	([3])	41	7.6	.....	.....	.....	.....
Ohio	24,219	27,683	38,641	44,746	[1]3,464	[1]12.5	[1]10,958	[1]28.4	[1]6,105	[1]13.6
Oklahoma	21	.....	.....	.....	21	.....	.....	.....	.....	.....
Oregon	21,588	9,469	9,255	5,806	12,119	128.0	214	2.3	3,449	59.4
Pennsylvania	86,223	82,534	110,276	141,982	3,689	4.5	[1]27,742	[1]25.2	[1]31,706	[1]22.3
Rhode Island	29,035	27,258	22,240	18,481	1,777	6.5	5,018	22.6	3,759	20.3
South Carolina	35,019	16,399	13,373	10,395	18,620	113.5	2,526	18.2	3,478	33.5
South Dakota	1,466	1,052	([3])	([3])	414	39.6	.....	.....	.....	.....
Tennessee	24,838	15,477	18,564	19,514	9,361	60.5	[1]3,087	[1]16.6	[1]950	[1]4.9
Texas	3,782	2,633	2,508	1,830	1,149	43.6	125	5.0	678	37.1
Utah	4,028	2,492	3,535	2,169	1,536	61.6	[1]1,043	[1]29.5	1,366	63.0
Vermont	87,615	74,376	52,226	44,897	13,239	17.8	22,150	42.4	7,329	16.3
Virginia	45,583	36,663	37,464	41,202	8,920	24.3	[1]801	[1]2.1	[1]3,738	[1]9.1
Washington	7,148	4,851	1,185	1,412	2,297	47.4	3,666	309.4	[1]227	[1]16.1
West Virginia	10,273	10,542	9,454	10,195	[1]269	[1]2.6	1,088	11.5	[1]741	[1]7.3
Wisconsin	99,007	56,841	45,356	33,714	42,166	74.2	11,485	25.3	11,642	34.5
Wyoming	667	216	38	34	451	208.8	178	468.4	4	11.8

[1] Decrease. [2] See North Dakota and South Dakota. [3] See Dakota.

The statistics relating to the use of waterpower for manufacturing purposes in 1900, compared with corresponding figures for 1890, 1880, and 1870, are significant of an interesting phase of power utilization, particularly during the past ten years.

The total amount of waterpower reported as used by manufacturing establishments in 1900 was 1,727,258 horsepower; 1,263,343 horsepower in 1890; 1,225,379 horsepower in 1880; and 1,130,431 horsepower in 1870. The increase from 1890 to 1900 was 463,915 horsepower, or 36.7 per cent. From 1880 to 1890 the increase was 37,964 horsepower, or 3.1 per cent, while from 1870 to 1880 there was an increase of 94,948 horsepower, or 8.4 per cent. In 1900 waterpower constituted 15.3 per cent of the total, as compared with 21.2 per cent in 1890, 35.9 per cent in 1880, and 48.2 per cent in 1870. Apparently the use of waterpower for manufacturing purposes has decreased relatively in thirty years from nearly one-half of the total motive power to less than one-sixth.

The decrease in the actual importance of waterpower is evidently less marked than these figures would seem to indicate; for consideration should be given to the fact that a very large portion of the electric motors reported in 1900 were driven by current developed by waterpower. For example, almost all the power developed by the great hydraulic installation at Niagara Falls is electrically transmitted, and consequently is reported as electric power by the manufacturing establishments in which it is used. Many textile plants are operated by electric current from distant generators driven by waterpower. In this way a large portion of the waterpower actually used in manufacturing operations does not appear in the census returns because it is electrically transmitted and is accounted for in the motors that are reported. It is obvious, therefore, that the use of waterpower in 1900 was considerably larger than indicated by the amount reported.

While the number of water wheels in use has decreased from 55,404 in 1880 to 39,182 in 1900, a loss of 16,222 wheels, or 29.3 per cent of the number in use in 1880, the aggregate power of the wheels in use increased during the same interval from 1,225,379 horsepower to 1,727,258 horsepower, a gain of 501,879 horsepower, or 41 per cent. This very large decrease in the number of wheels and great increase in the aggregate power points to the large increase in the size of the units, which in 1880 averaged only 22.1 horsepower each, but which in 1900 was 44.1 horsepower, or twice as large. This is due to the abandonment of many small wheels of antiquated type and the substitution therefor of fewer units of larger size and greater efficiency. In many instances, too, it has been necessary to abandon entirely the use of waterpower, either because of failing supply or the larger requirements of expanding industry, and this has removed a considerable number of wheels, mostly of small size.

The use of water as a primary source of power has undergone a complete transformation during the past decade, both in the methods of its utilization and in the manner of transmitting and applying the power. Prior to 1890 the largest use of waterpower was in its direct application to machinery in manufacturing establishments at the immediate point of development. During the past ten years, however, the use of electricity as an agency for the transformation and transmission of the energy developed by falling water has entirely changed the conditions under which such primary power can be utilized to advantage. The practical possibility of transmitting power thus developed over long distances has removed the necessity for building mills immediately adjacent to waterpowers, often so located as to present serious physical obstacles to the economical arrangement and construction of manufacturing plants. This has rendered available many waterpowers which otherwise could not have been utilized to advantage, and thus has largely increased the industrial possibilities of many localities where a limited or expensive fuel supply has made the use of steam power impracticable.

Electrical transmission has rendered possible the advantageous utilization of waterpower in several distinctly new forms, such as the large central stations for the distribution of power to numerous plants, as, for example, at Niagara Falls; the use of remote mountain waterpowers for the operation of single plants, often many miles distant, of which so many notable examples are to be found in the far West; and the more advantageous use of larger streams on the Atlantic coast, usually in closer proximity to the mills, but under conditions which would present many difficulties without the useful agency of the electrical current.

The significant increases in the use of waterpower in different states, as indicated in table IV, are readily accounted for by the growth of certain industries, mainly the manufacture of paper and wood pulp. The largest increase is shown for New York, and this is directly traceable to the great expansion of the wood-pulp industry. In the paper and pulp mills in New York, waterpower was used to the extent of 65,052 horsepower in 1890, and 191,117 horsepower in 1900. This industry alone, therefore, accounts for 126,065 horsepower of the increase of 134,661 horsepower in that state from 1890 to 1900.

In Maine, where the next largest increase took place, the cause was the same, the use of waterpower in paper and pulp mills having increased from 20,320 horsepower in 1890 to 75,839 horsepower in 1900, an increase of 55,519 out of a total increase of 60,744 horsepower.

In the paper and pulp mills in New Hampshire 38,200 horsepower was used in 1900, as compared with 4,405 horsepower in 1890, an increase of 33,795 horsepower,

which accounted for the major part of the total increase of 43,722 horsepower in that state.

The increase of 28,061 horsepower in the use of waterpower in Massachusetts from 1890 to 1900 was due to the larger use of this power in the paper and cotton industries. In 1890, 29,148 horsepower was reported in paper mills, and 44,935 horsepower in 1900, an increase of 15,787 horsepower. In the cotton mills of this state waterpower to the extent of 55,944 horsepower was used in 1890, and 64,158 horsepower in 1900, an increase of 8,214 horsepower. Together these industries account for 24,001 horsepower of the total increase of 28,061 horsepower.

In Wisconsin the entire increase in the use of waterpower is attributable to the growth of the pulp and paper industry, in which 61,287 horsepower was used in 1900, compared with 19,131 horsepower in 1890, an increase of 42,156 horsepower. The total increase for the state was 42,166 horsepower.

In North Carolina, where there was an increase of 25,210 horsepower, the conditions were somewhat different. Waterpower reported in cotton mills increased from 7,959 horsepower in 1890 to 19,225 horsepower in 1900, or 11,266 horsepower. The amount of waterpower reported in flour and grist mills in 1890 was 19,874 horsepower, and in 1900, 28,658 horsepower, an increase of 8,784 horsepower. The increase in the two industries was 20,050 horsepower out of the total increase of 25 210 horsepower.

VI.

ELECTRIC POWER.

The most notable phase of the application of power to industrial uses during the decade 1890–1900 is the use of the electric current for the transmission and subdivision of power. This form of power transmission and distribution is almost wholly a development of the past ten years, although the principles involved were known and their practical utility demonstrated at a much earlier period. Prior to 1890 the census returns did not state separately the number of motors in use or the amount of electric power utilized in manufacturing establishments, such power being merged in the group of "other power."

In 1890 the number of motors in use was not reported, and the only information on this point was embraced in the quantity of electric power used, which amounted to 15,569 horsepower. In 1900 the amount of electric power reported was 311,016 horsepower, showing an increase of 295,447 horsepower, or nearly nineteenfold. The number of motors reported in 1900 was 16,923, giving an average of 18.4 horsepower per motor. In 1890 electric motors represented only 0.3 per cent of the total power, while in 1900 they constituted 2.7 per per cent of the total.

Electric motors have been known for three-quarters of a century, and, at least seventy years ago, were applied experimentally to the propulsion of boats and cars and to the operation of machinery.[1] But as they depended for their supply of current upon primary batteries consuming zinc, costly chemicals, etc., they could make no place in the industries of the world. The perfection of the dynamo and the discovery of the fact that the dynamo was reversible—i. e., that if current were supplied to it, it would run as a motor—released electric power from the trammeling conditions that had hindered its development, and the art made an immense stride forward, particularly in America, so that when the first electrical exhibition in the United States was held at Philadelphia in 1884, the electric motors shown compared in number, efficiency, and commercial practicability with the arc and incandescent lamps, telephones, telegraphs, and other devices.

When the Eleventh Census was taken, such motors were beginning to appear upon the circuits of electric lighting companies and hopes were entertained that independent power plants for mills and factories would multiply. The returns for New York show that in 1890 there were 360 motors in use in New York city in isolated plants of a total of 310 horsepower, and that in all of the state outside there were only 99 motors of 862 horsepower. In the central stations of the state, outside of New York city, there were 1,178 motors of 1,276 horsepower, and in the city of New York (Manhattan Island) there were 1,185 motors of 1,678 horsepower.

No statistics that would indicate growth are available as to the state, but in New York city (Manhattan Island) the New York Edison Company reported for 1900–1901 a total of 50,634 horsepower of motors connected to its circuits, showing a motor capacity in 1900-1901 more than thirty times as great as in 1890, considering only the figures of one company.

A corresponding increase is observable in most of the other large cities in the Union. In the city of Boston alone there are now connected to central station power and lighting mains not less than 4,470 motors of a total capacity of 16,059 horsepower, which, in proportion to population, is larger than can be claimed for New York city.[2]

1. *Power Transmission.*—The development of electric motors in this country has been accompanied by a corresponding development of the art of power transmission. But for the higher perfection of the electric motor since 1890, it may be doubted whether the transmission of electric energy would have been undertaken on anything like so large a scale as was witnessed at the close of the century. During the ten years preceding 1890 the development of motors and of power transmission work was chiefly by means of direct current, but the last decade has seen a remarkable change in methods of current generation, enabling the creation

[1] The Electric Motor and Its Application, 1886. Pages, 8–13 et seq.

[2] Seventeenth Annual Report of the Board of Gas and Electric Light Commissioners, Massachusetts, 1902.

of new centers of manufacture around waterpowers and permitting the transmission of electricity over distances which were previously deemed utterly prohibitive.

The great bulk of electric-motor work is still done with direct current, there being no alternating-current motors in use for railway work; and in stationary work, that is, in mills, factories, mines, etc., the utilization of alternating-current motors, measured by their number and value, is only about 25 per cent as large as that of the direct current.

2. *Niagara Falls.*—The development of electric power transmission at Niagara Falls has been the largest, and the most conspicuous of its kind, and the work done there is in many respects typical of that done in other sections of the country where waterpower is abundant, although as to the length of transmission and the voltage at which the current is sent over long distances, it is by no means the best example that can be found.

The utilization of Niagara has in fact gone on for some time, and there are at the present time two separate and distinct enterprises on the American side—one above and the other below the Horseshoe falls. The plant below the falls has the water of the Niagara river brought to it by a long canal which taps the Upper Niagara river, runs through the city of Niagara Falls, and then discharges the waste water at the cliff just below the first suspension bridge. Here there is a fall of about 215 feet, considerably more than at the plant above, but there is the disadvantage that the turbines and dynamos are located in the gorge, which the buildings disfigure, and that the conditions are not so favorable for the operation of machinery as in a plant at the surface.

It is the plant above the falls, developed by the Niagara Falls Power Company, the current of which, while used locally in large amounts, is also transmitted to Buffalo, 26 miles distant, that has attracted the greatest public attention. This includes a short service canal, 250 feet wide at its mouth, 1¼ miles above the falls, the intake being inclined obliquely to the Niagara river. The canal extends inwardly 1,700 feet, with an average depth of 12 feet, and holds water adequate to the development of over 100,000 horsepower. On each side is a power house, the ultimate capacity of each being 50,000 horsepower, one of which is in full operation and the other in course of equipment with machinery.

The electric generators are at the surface, and the water wheels which drive them are in a wheel pit 150 feet under ground, being connected by a steel shaft; the water reaches the wheels through steel tubes. After the water has delivered up its energy, it is carried off by means of a tunnel 7,000 feet in length with an average slope of 6 feet in 1,000. This tunnel, which has a net section of about 386 square feet, empties just under the first suspension bridge, where the waste water rushes out with a speed of nearly 20 miles an hour.

The Niagara Falls Power Company has under its charter the right to take sufficient water from the upper river to develop 200,000 horsepower, and has large franchises also on the Canadian side. The development of its work has gone on without in anywise marring the beauty of the spot, while the diversion of water is obviously too small to make any perceptible difference in the amount passing over the crest of the Horseshoe or American falls; the potential power of the main stream is estimated to be equal to at least six or seven million horsepower.

The first power house of the company, which has now been in operation for some time, contains 10 dynamos of 5,000 horsepower each. Between this and the other is a large transforming station, at the end of the canal, where huge transformers are grouped for raising the current of 2,200 volts to a pressure of 22,000 volts for transmission to Buffalo, and to 11,000 volts for utilization on the company's own factory land, and by a large variety of industries already concentrated along the bank of the Niagara river toward Tonawanda.

These are the leading features of the generation of current above the falls on the American side, but the American company has already given out contracts for a large plant on the Canadian side, where the current will be developed by the largest dynamos in the world, built in the United States, and can, if necessary, be brought across the river for use in this country. The dynamos, 3 in number, will each deliver 10,000 horsepower to the circuits, returning 98 per cent of the shaft horsepower in the form of current generated at a potential of 12,000 volts, thus dispensing with transformers, which otherwise would be required to raise it to that voltage for transmission.

A large amount of Niagara current is employed in electro-chemical and electro-metallurgical operations. This work, however, is far from exhausting the possibilities of Niagara development by electricity. In the immediate vicinity of the falls, the current is now used for electric lighting, and about 1,000 horsepower is also delivered to the street railway trolley system. Factories on the spot working up raw material into food, textile fabrics, etc., utilize several hundreds of horsepower, and the current is also used for the manufacture of "merry-go-rounds," as well as for operating ventilating blowers in the public schools.

It is the transmission to Buffalo, however, which more particularly justifies the utilization of the energy of the great cataract, and illustrates the remarkable manner in which electric power is modifying the methods of American manufacturing and mechanical industries. The current from Niagara to Buffalo is carried over aerial circuits and delivered to transformer stations which lower the pressure for local distribution. The Buffalo street railway system has five of these substations, so that at all hours of the day and night, Niagara is transporting the public of a great city more than 20 miles distant.

There are a number of miscellaneous industries and

manufactures in which blocks of Niagara current are used at prices which compete so favorably with those of steam, oil, and natural and artificial gas, that the demand is rapidly increasing. Among these may be mentioned large flouring mills and a plaster-making plant.

Not only is grain ground to flour by electrical power, but it is handled by electricity in some of the largest grain elevators for which Buffalo is famous, one of them, the "Great Northern," having 20 induction motors of an aggregate capacity of 1,200 horsepower. Another large utilization is at the plant of the Buffalo Dry Dock Company, where 40 motors of upward of 500-horsepower capacity are employed in the process of building some of the largest steel steamships that ply the Great Lakes.

At one of the branches of the American Agricultural Chemical Company are employed 15 motor units of a total capacity of 300 horsepower, and at the New York Car Wheel Works 4 motors of about 200 horsepower, driving air compressors, blowers, lathes, boring mills, grinding machines, presses, etc. The proprietors of the Curtiss Malt Mills use a motor capacity of about 300 horsepower for manipulating malt; the American Bridge Company have motors aggregating 125 horsepower engaged in the manufacture of structural steel; the Oliver Manufacturing Company, manufacturers of jewelers' supplies, etc., employ 50 horsepower of Niagara current, while the Pratt & Letchworth Company, manufacturers of heavy steel and malleable iron castings, utilize 300 horsepower.

One of the most interesting utilizations, however, is that of 20 horsepower in a bread bakery. In another building, 3 motors operate ice machines twenty-four hours a day, to furnish refrigeration for a market place on the other side of the street. Last, but not least, is the supply of current to the Buffalo General Electric Company, which, prior to 1900, was operating two large and distinct stations driven by steam power. These have been consolidated and the operating department thus reduced one-half, while the displacement of steam power and steam engines has further diminished the amount of labor necessary, as the large motors driving the generators which feed thousands of lamps and motors need few attendants.

3. *The Pacific Coast.*—An advance beyond the utilization of the power of Niagara Falls is that developed during the census year, and more recently perfected, by means of which electric current is transmitted from the Sierras in eastern California as far as San Francisco and other cities adjacent to the Pacific seaboard. This constitutes the longest electric power transmission in the world, the distance being nearly ten times that on the American side of Niagara falls. A further striking difference is that whereas the development at Niagara is due to the falling of water in huge volume under a head of only from 150 to 200 feet, in California large enterprises depend upon the utilization of relatively small bodies of water, but with heads of from 500 to 1,500 and 1,800 feet. In that state, where fuel is still scarce and dear, a great many mining plants have been brought within the sphere of feasibility by this electric power transmission, and a large amount of miscellaneous work throughout the state is now tributary to these long-distance transmissions, which excel in daring, in number, and in commercial success anything attained elsewhere in the world.

The transmission of the power of the North Yuba river, in the Sierras, to San Francisco, above referred to, effected by the Bay Counties and Standard systems, stretches across and ramifies through no fewer than 16 counties, containing property to the amount of three-fifths of the assessed valuation, and about one-half of the population of the state. The systems have two sources of supply, one at Colgate, over 200 miles from the Golden Gate, and the other at Electra, about 150 miles distant, these systems meeting on San Francisco bay, at Mission San Jose and at Oakland.

The power plant at Colgate is situated at the base of a 1,500-foot hill, down the side of which extend five steel pipes, each 30 inches in diameter, delivering water to the turbines. Water is brought to these pipes from the impounded river and from a remote watershed by means of a timber flume over 7 miles in length with a capacity of carrying 23,000 cubic feet of water per minute. The turbines drive 3 generator dynamos of 3,000 horsepower each, and 4 of 1,500 horsepower each, these being of the "three-phase" current type. The current is generated in these dynamo machines at 2,400 volts pressure, and is then raised by transforming apparatus to a pressure of 40,000 and 60,000 volts, even 80,000 volts having been reached, while the lowest pressure named is normal. This current is delivered to two circuits of 3 wires each, one being composed of copper and the other of aluminum. The wires are carried upon Oregon cedar poles averaging from 25 to 60 feet high, upon which are screwed porcelain and glass umbrella insulators 12 inches in diameter.

The transmission current is carried across the well-known Straits of Karquines in an enormous span of 4,448 feet, supported 200 feet above the rapid waters emptying into San Pablo Bay by means of steel latticed towers, the circuits being composed of stranded plow steel to obtain the requisite tensile strength.

The efficiency of the transmission system is such that 1,000 horsepower at the Colgate water wheels nets about 750 horsepower at San Francisco, 6 per cent being lost in the generators, 2 per cent in the step-up transformers, 2 per cent in the step-down transformers at the receiving substations, and 15 per cent in regulation and in the line.

The employment of the current is not less varied than at Niagara, ranging from the operation of street cars in Oakland to the running of a flour mill at Stockton, and from use in mines in various parts of the state to use in miscellaneous industries at Sacramento, Benicia, San Jose, and elsewhere. The plants must be main-

tained in regular and systematic operation, and as their initial base of dependence is the water supply, storage reservoirs have been provided in the high Sierras in Alpine county, 6,000 to 8,000 feet above the sea level, furnishing a supply equal to one hundred and fifty days, which is the maximum dry period of the state as recorded in its annals.

The third type of power transmission plant which deserves mention is that at the Snoqualmie falls, Washington, where the dynamo room with 10,000 horsepower of electrical apparatus is situated 250 feet below the surface in a large whitewashed cavern, blasted and hewn from the solid rock. This unique location is due to the fact that the spray from the falls rendered it impossible to locate any power house at the surface. The current is transmitted across the Cascade Mountains through dense forests to the cities of Seattle and Tacoma, where electric lights, railways, and motors are operated; and, here again, it is to be noted that aluminum is used for transmission circuits.

4. *Sault Sainte Marie.*—The Saint Marys River, which flows from Lake Superior into Lake Huron and separates the upper peninsula of Michigan from Canada, has been utilized for power development upon an extensive scale during the last few years. The conditions here are somewhat different from the illustrations previously described, as instead of a comparatively small flow of water at great head, an enormous volume of water with a comparatively small head is used. The difference in the levels of the two lakes is about 20 feet, most of the fall occurring in the rapids known as Saint Marys falls, or Sault Sainte Marie, at the outlet of Lake Superior. On the Canadian side of the river a power canal has been in use for several years, yielding about 20,000 horsepower, a large portion of which is used direct from the turbines for driving wood-pulp grinders. The remainder is electrically transmitted to various industries.

On the American side of the river a much larger power development is approaching completion. A canal about 2¼ miles in length, from 200 to 250 feet in width, and of an average depth of about 20 feet, has been cut from Lake Superior to a point on Saint Marys river below the rapids. A massive power house of steel, stone, and concrete, over 1,300 feet in length, will contain 320 horizontal turbines, capable of developing about 50,000 horsepower. All of this power will be transmitted by electricity to industries in the vicinity on both sides of the river.

A third canal of similar proportions is to be constructed on the Canadian side of the river, paralleling the one now in operation on that side.

A unique feature of this great development is the precaution taken to prevent possible lowering of the level of Lake Superior or interference with the vast steamship traffic which passes through the locks at the rapids. Lest the increased outlet afforded by canals should lessen the flow of water through the steamship locks and their approaches, compensating works are being constructed at the head of the rapids for the purpose of reducing, by means of movable gates, the outflow over the falls in proportion to the increased outlet created by the power canals. It is designed, by this means, to maintain the flow of water from Lake Superior as a fixed quantity, regardless of the new outlets afforded by the power canals.

The following table presents the essential features of a number of the characteristic waterpower developments which transmit electric power over long distances:

TABLE V.—*Companies engaged in long-distance power transmission.*

NAME AND LOCATION OF COMPANIES	Capacity, horsepower.	Length of line, miles.	Line voltage.	Distribution.
Montgomery Water Power Company, Tallassee, Ala	3,500	30	30,000	3 phase.
Bay Counties and Standard Power companies, Marysville and Electra, Cal	6,300 10,000	140 220	60,000	3 phase.
Blue Lakes Water Company, Bigbar Bridge, Cal	1,800	40, 20	10,000 25,000	2 phase.
Central California Electric Company, Newcastle, Cal	1,700	35, 28	15,800	2 phase.
Jamestown Light and Power Company, Jamestown, Cal	1,500	15	16,000	3 phase.
Power Development Company, Bakersfield, Cal	1,200	16	10,000	3 phase.
Redlands Electric Light and Power Company, Redlands, Cal	1,840	21	10,000	3 phase.
Sacramento Electric, Gas, and Railway Company, Folsom City, Cal	4,000	22.5	11,000	3 phase.
San Gabriel Electric Company, Azusa, Cal	1,200	23	15,000	2 phase.
San Joaquin Electric Company, Fresno, Cal	1,400	55, 35	11,000 19,000	3 phase.
Southern California Power Company, Redlands, Cal	4,000	80	33,000	3 phase.
Tuolumne County Water Company, Sonora, Cal	1,500	10	15,000	3 phase.
Truckee River Power Company, Truckee River, Cal	2,000	33	22,000	3 phase.
Yuba Power Company, Marysville, Cal	1,200	19	16,000	2 phase.
Colorado Electric Power Company, Colorado Springs, Colo	1,875	25	20,000	3 phase.
Ouray Electric Light and Power Company, Ouray, Colo	1,200	7	12,000	2 phase.
Pikes Peak River Company, Victor, Colo	2,000	10	12,000	3 phase.
San Miguel Consolidated Gold Mining Company, Telluride, Colo	1,600	25	11,600	2 phase.
Hartford Electric Light Company, Hartford, Conn	4,000	11	10,000	2 phase.
Lewiston, Brunswick, and Bath Railway Company, Lewiston, Me	1,000	20, 10	10,500	3 phase.
Sanford Power Company, Sanford, Me	2,000	9	10,500	2 phase.
Kalamazoo Valley Electric Company, Kalamazoo, Mich	2,000	46	40,000	3 phase.
St. Anthony Falls Water Company, Minneapolis, Minn	7,500	10	12,000	3 phase.
St. Croix Power Company, St. Paul, Minn	4,000	28	30,000	3 phase.
Helena Water and Electric Power Company, Helena, Mont	4,000	11, 8	11,000	2 phase.
Missouri River Power Company, Canyon Ferry, Mont	4,800	70	50,000	2 phase.
Montana Power Company, Butte, Mont	4,000	21	15,000 26,000	3 phase.
Manchester Traction, Light, and Power Company, Goffstown, N. H	1,600	6	10,000	3 phase.
Albany and Hudson Railway and Power Company, Kinderhook, N. Y	3,000	18	12,000	3 phase.
Empire State Power Company, Amsterdam, N. Y	2,400	17	12,000	3 phase.
Hudson River Power Transmission Company, Mechanicsville, N. Y	5,000	18, 14	12,000	3 phase.
Niagara Falls Power Company, Niagara Falls, N. Y	50,200	27	11,000 22,000	2 phase.
Utica Electric Light and Power Company, Utica, N. Y	4,000	12	22,000	3 phase.
Fries Manufacturing and Power Company, Salem, N. C	1,000	15	12,000	3 phase.
Lehigh Power Company, Easton, Pa	1,500	3¼	12,000	3 phase.
Anderson Water, Light, and Power Company, Anderson, S. C	3,000	10	11,200	2 phase.
Big Cottonwood Power Company, Big Cottonwood Canyon, Utah	2,675	14	10,000	3 phase.
Pioneer Electric Power Company, Ogden, Utah	5,000	40	15,000 26,000	3 phase.
Salt Lake City Water and Electric Power Company, Big Cottonwood Canyon, Utah	2,000	12	16,000	2 phase.
Telluride Power Transmission Company, Provo City, Utah	2,000	55	40,000	3 phase.
Utah Power Company, Salt Lake City, Utah	2,000	13	15,660	2 phase.
Snoqualmie Falls Power Company, Snoqualmie Falls, Wash	8,000	45, 81	25,000	2 phase.
Tacoma Railway and Power Company, Tacoma, Wash	1,340	45	13,000	2 phase.

5. *Electric Power in Cotton Manufactures.*—In cotton goods manufacture electric power is being rapidly adopted, not only in New England, but in the South; perhaps the most conspicuous examples can be found in the latter region, where waterpower has been largely utilized.

One of the earlier and larger plants at which waterpower was utilized for the generation of electric power is the Ponemah Mills, at Taftville, Conn., where the energy from the waterpower at Baltic, 4½ miles away, has been used for years to run the weaving mill of 1,700 looms, and to operate 1,200 incandescent lights. The generating plant consists of two alternating current generators of 350 horsepower each, and these drive two 350-horsepower motors at Taftville. A street-railway system is operated in connection with the mill, and an electric locomotive is employed to haul freight cars a distance of one mile.

The typical Southern mills utilizing waterpower are those at Columbia, and at Pelzer, S. C., the former requiring about 1,400 horsepower and the latter, 3,000 horsepower. At Pelzer the saving in the first cost of the shafting and belting, as compared with an identical mill driven by a mechanical system amounted to nearly $10,000. The success of the Columbia Mills led the owners to develop a large waterpower system of their own, from which are driven the Granby Mills, 1½ miles distant, using 1,800 horsepower in motors, and the Palmetto Mills, using 200 horsepower in motors. An even more striking instance of transmission of energy is that of the Anderson Cotton Mills, at Anderson, S. C., driven from the electric light plant at Portman Shoals, 10 miles away. Between the water wheels at the remote generating plant and the spinning frame in the mill there is not a single belt or auxiliary shaft. The increase in the quality of production obtained by the omission of belting is reported to have been very marked over the old-fashioned mechanically driven frames.

It happens, however, that the most typical Southern cotton mill operated by electric power is one in which the generators are not driven by water wheels but by steam power. Mr. W. B. Smith-Whaley, of the Columbia Mills already referred to, had found that the cost of repairs in an electric mill was about one-half that in a mechanically driven mill under the same ownership, although the latter was the smaller; and had also noted an increase of product, amounting to at least 4 per cent, due to the more uniform speed of the producing machinery. With this knowledge, when the Olympia Mill was located at Columbia, two sets of plans were drawn, one contemplating the distribution of power by small wires to motors, and the other by the old-fashioned system of belts and shafting throughout. Bids were obtained for both, with the result that the electrical system was found to be decidedly the cheaper.

There being no need of heavy transverse walls for the main shafts at the belt way, the use of electricity reduced the cost of the mill building 10 per cent. Sixty-one per cent of the line shafting cost was also saved, and 66 per cent of the cost of the belts and ropes. It is stated that the saving due to these three items was more than sufficient to pay for the cost of the electrical equipment.

The maximum power required by the mill is about 3,600 horsepower, furnished from the central mill plant through the generators, the same plant also supplying current to light the town and operate the street railway. Mr. Smith-Whaley states that the total cost of the Olympia Mill, on a basis of 10,000 spindles, is about $18.50 per spindle as against $15 per spindle for one of the best mechanically operated mills in New England. The $18.50, however, includes the laying out, sewering, water piping, etc., of 150 acres of land, the construction of 325 cottages, and the providing of 2,400 horsepower above all necessities, which can be disposed of to outside parties. The aggregate of these three items makes a difference of $4.96 per spindle, leaving $13.54 per spindle as the proper cost in comparison with the New England mill. It should also be mentioned that the Olympia Mill is equipped with 2,400 40-inch Draper looms, each costing $85 more than the looms in the other mill. The electric current is distributed by 22 induction motors of 150 horsepower each, as well as by several smaller motors for miscellaneous purposes.

6. *Government Printing Office.*—Electric motors doing miscellaneous work in manufacturing establishments are scattered so widely throughout the field of industry that it is impossible to consider them all in detail. It will suffice, perhaps, to note the figures given by Mr. W. H. Tapley, electrician of the Government Printing Office, at Washington, D. C., where the advantages have been so marked that the new office, the largest of its kind in the world, is being equipped throughout with electric power. At the time Mr. Tapley made his report—the period of the census year—the office had, connected with the power circuits, 575 electrical horsepower of motors for presses, etc., and 125 horsepower of motors for elevators. The most marked feature of economy mentioned by Mr. Tapley is in the increase of 15 per cent in the output of the press room. If there is any printing office where trustworthy power conditions must be had, it is that of the Government, the plant being run twenty-four hours daily during the sessions of Congress. Mr. Tapley states that there has never been a hitch in the motive power. "In fact, such a freedom from interruption of power has not been known in the history of the office as during the past three years, or since we have adopted electric power."

7. *Economies of Electric Power.*—The economies introduced into the manufacturing processes of the United

States by electric power may be summed up generally or may be treated under separate heads; perhaps the best method of consideration is to cite the arguments usually advanced and then to mention a few typical cases in support of them.

Prof. F. B. Crocker, of Columbia University, in a recent classical discussion of the subject before the Franklin Institute, Philadelphia, Pa., enumerated the principal advantages obtained by employment of electric power in mills and factories as follows:

1. A real economy in amount of power used.
2. A reduction in cost of the construction of buildings, which can be lighter, owing to the fact that there is no need to install heavy lines of shafting and pulleys.
3. A reduction in expense of service, such as oiling, depreciation, etc.
4. More efficient arrangement of machines and tools, which need no longer be placed in straight lines parallel with the shafting, but can be located exactly as desired.
5. Access to the machinery is easier from the suppression of belts and pulleys.
6. Greater cleanliness, as there is less dust and no scattering of oil or steam, etc.
7. Hygienic conditions are improved, owing to the diminution of dust and dirt; better light, owing to the absence of shafting, pulleys, etc.; the lessening of noise, etc.
8. Greater ease of placing different shops in separate buildings and in locating them according to the strict requirements of the work and without regard to the necessities of the motive power.
9. Greater facility in the increase of establishments.
10. Localization of accidents due to motive power, with consequent less injury to individuals and the stoppage of work only at the point where an individual motor is incapacitated.
11. Greater control of the speed of the tools.
12. A marked increase in the product of any given establishment.

In signalizing these advantages Professor Crocker divided the application of motors to manufacturing into three classes. The first method consists in connecting the motor directly with the machine. The second consists in the interposition of gearing to reduce or increase speed. The third depends upon the utilization of auxiliary shafting and belting. The cases cited herewith of the application of electric motors come within the range of the points enumerated.

At the thirty-third annual convention of the American Railway Master Mechanics' Association in 1900 an elaborate and interesting report was made by a special committee on power transmission by shafting versus electricity for railroad shops. One of the most significant cases cited was that of the Baldwin Locomotive Works, where not quite 1,000 horsepower in electric current was utilized at the time for power purposes. Electricity was first introduced in the erecting shop for driving two 100-ton cranes, and an immediate saving of 80 men was effected. In the wheel shop the "common labor" force was reduced from 40 men to 6; the time consumed in reloading a lathe was cut down from 30 minutes to 5; and the saving in power in that shop was estimated at fully 50 per cent. In the frame shop the laboring force was reduced 60 per cent. The fuel economy, involving a possible reduction of $120 per week, was but one item. The saving on labor was stated at $1,800 per week. The increase in output was large.

VII.

STATISTICS OF POWER IN SELECTED INDUSTRIES.

Table VI shows the total horsepower used, by classes, in a few of the larger manufactures, 1870 to 1900, with the amount and percentage of increase in each decade.

TABLE VI.—POWER USED IN MANUFACTURE BY SELECTED INDUSTRIES, 1870 TO 1900, WITH AMOUNT AND PER CENT OF INCREASE FOR EACH DECADE.

INDUSTRIES.	TOTAL HORSEPOWER.				INCREASE.					
	1900	1890	1880	1870	1890 to 1900.		1880 to 1890.		1870 to 1880.	
					Amount.	Per cent.	Amount.	Per cent.	Amount.	Per cent.
All industries	11,300,081	5,954,655	3,410,837	2,346,142	5,345,426	89.8	2,543,818	74.6	1,064,695	45.4
Agricultural implements	77,189	50,395	44,731	26,082	26,794	53.2	5,664	12.7	18,649	71.5
Boots and shoes, factory product	51,073	30,686	11,574	3,055	20,387	66.4	19,112	165.1	8,519	278.9
Cotton goods[1]	811,347	464,881	275,504	146,040	346,466	74.5	189,377	68.7	129,464	88.7
Flouring and grist mill products	1,016,859	752,365	771,201	576,686	264,494	35.2	[2]18,836	[2]2.4	194,515	33.7
Hosiery and knit goods	58,087	34,538	11,561	6,498	23,549	68.2	22,977	198.8	5,063	77.9
Iron and steel	1,670,547	745,824	397,247	170,675	924,723	124.0	348,577	87.7	226,572	132.8
Lumber and timber products	1,613,747	961,316	821,928	641,665	652,431	67.9	139,388	17.0	180,263	28.1
Paper and wood pulp	764,847	297,724	123,912	53,218	467,123	156.9	173,812	140.3	70,694	132.8
Silk and silk goods	61,395	29,638	8,810	1,911	31,757	107.2	20,828	236.4	6,899	361.0
Woolen goods	139,645	122,501	106,507	85,101	17,144	14.0	15,994	15.0	21,406	25.2
Worsted goods	97,383	57,111	16,437	8,016	40,272	72.3	40,674	247.5	8,421	105.1
All other industries	4,937,962	2,407,676	821,425	627,195	2,530,286	105.1	1,586,251	193.1	194,230	81.0

[1] Includes cotton small wares.

[2] Decrease.

TABLE VI.—POWER USED IN MANUFACTURE BY SELECTED INDUSTRIES, 1870 TO 1890, WITH AMOUNT AND PER CENT OF INCREASE FOR EACH DECADE—Continued.

INDUSTRIES.	STEAM HORSEPOWER.				INCREASE.					
	1900	1890	1880	1870	1890 to 1900.		1880 to 1890.		1870 to 1880.	
					Amount.	Per cent.	Amount.	Per cent.	Amount.	Per cent.
All industries	8,742,416	4,662,029	2,185,458	1,215,711	4,080,387	87.5	2,476,571	113.3	969,747	79.8
Agricultural implements	61,147	40,673	32,086	15,873	20,474	50.3	8,587	26.8	16,213	102.1
Boots and shoes, factory product	34,816	27,885	11,164	2,892	6,931	24.9	16,721	149.8	8,272	286.0
Cotton goods[1]	531,611	265,509	126,750	46,967	266,102	100.2	138,759	109.5	79,783	169.9
Flouring and grist mill products	533,755	366,587	301,214	168,736	167,168	45.1	65,373	21.7	132,478	78.5
Hosiery and knit goods	39,693	22,005	6,069	2,223	17,688	80.4	15,936	262.6	3,846	173.0
Iron and steel	1,581,695	737,771	380,741	154,091	843,924	114.4	357,030	93.8	226,650	147.1
Lumber and timber products	1,401,883	759,078	543,242	314,884	642,805	84.7	215,836	39.7	228,358	72.5
Paper and wood pulp	255,854	93,659	36,301	11,574	162,195	173.2	57,358	158.0	24,727	213.6
Silk and silk goods	45,959	24,427	7,248	1,122	21,532	88.2	17,179	237.0	6,126	546.0
Woolen goods	82,933	67,195	52,897	32,195	15,738	23.4	14,298	27.0	20,702	64.3
Worsted goods	73,180	44,458	10,135	3,382	28,722	64.6	34,323	338.7	6,753	199.7
All other industries	4,099,890	2,212,782	677,611	461,772	1,887,108	85.3	1,535,171	226.6	215,839	46.7

INDUSTRIES.	WATER HORSEPOWER.				INCREASE.						ALL OTHER POWER.		INCREASE.	
	1900	1890	1880	1870	1890 to 1900.		1880 to 1890.		1870 to 1880.		1900	1890	1890 to 1900.	
					Amount.	Per cent.	Amount.	Per cent.	Amount.	Per cent.	Amount.	Amount.	Amount.	Per cent.
All industries	1,727,258	1,263,343	1,225,379	1,130,431	463,915	36.7	37,964	3.1	94,948	8.4	830,407	29,283	801,124	2,735.8
Agricultural implements	6,758	9,667	12,645	10,209	[2]2,909	[2]30.1	[2]2,978	[2]23.6	2,436	23.9	9,284	55	9,229	16,780.0
Boots and shoes, factory product	2,390	1,874	410	163	516	27.5	1,464	357.1	247	151.5	13,867	927	12,940	1,395.9
Cotton goods[1]	251,850	198,982	148,754	99,078	52,868	26.6	50,228	33.8	49,681	50.2	27,886	390	27,496	7,050.3
Flouring and grist mill products	451,378	383,872	469,987	407,950	67,506	17.6	[2]86,115	[2]18.3	62,037	15.2	31,726	1,906	29,820	1,564.5
Hosiery and knit goods	14,824	12,360	5,492	4,275	2,464	19.9	6,868	125.1	1,217	28.5	3,570	173	3,397	1,963.6
Iron and steel	8,649	8,053	16,506	16,584	596	7.4	[2]8,453	[2]51.2	[2]78	[2]0.5	80,203	.....	80,203	.....
Lumber and timber products	200,983	201,651	278,686	326,781	[2]668	[2]0.3	[2]77,035	[2]27.6	[2]48,095	[2]14.7	10,881	587	10,294	1,753.7
Paper and wood pulp	504,762	203,896	87,611	41,644	300,866	147.6	116,285	132.7	45,967	110.4	4,231	169	4,062	2,403.6
Silk and silk goods	6,666	4,864	1,562	789	1,802	37.0	3,302	211.4	773	98.0	8,770	347	8,423	2,139.2
Woolen goods	52,358	55,030	53,610	52,906	[2]2,672	[2]4.9	1,420	2.7	704	1.3	4,354	276	4,078	1,477.5
Worsted goods	20,491	12,437	6,302	4,634	8,054	64.8	6,135	97.4	1,668	36.0	3,712	216	3,496	1,618.5
All other industries	206,149	170,657	143,814	165,423	35,492	20.8	26,843	18.7	[2]21,609	[2]13.1	631,923	24,237	607,686	2,507.2

[1] Includes cotton small wares.

Of the industries here shown, the manufacture of paper and wood pulp shows the largest percentage of increase in the amount of power used in 1900 compared with 1890—from 297,724 to 764,847 horsepower, an increase of 467,123, or 156.9 per cent. This increase was chiefly in the use of waterpower, which amounted in 1900 to 504,762 horsepower, compared with 203,896 in 1890, a gain of 300,866 during the ten years. In no other industry has there been so large an increase at any time during the thirty years.

The largest use of power, however, in 1900 was in the manufactures of iron and steel—1,670,547 horsepower compared with 745,824 in 1890, an increase of 924,723, or 124 per cent. This is a larger absolute increase than in any other industry. Next to the largest use was in the manufacture of lumber and timber products. For the sawmills of the country there was used in 1900 a total of 1,613,747 horsepower, compared with 961,316 in 1890, a gain of 652,431, or 67.9 per cent. This increase was almost wholly in the use of steam, which in 1900 was 1,401,883 horsepower, and in 1890, 759,078, an increase of 642,805, or 84.7 per cent. The use of waterpower in this industry has shown a continuous decrease during the past thirty years, having fallen from 326,781 horsepower in 1870 to 200,983 in 1900, or 38.5 per cent. In no other industry of magnitude has there been such a substitution of steam for waterpower.

Flouring and grist mills rank next, with 1,016,859 horsepower in 1900, an increase of 264,494 over 1890, or 35.2 per cent. This increase was more largely in steam than in waterpower, as the former constituted 167,168 horsepower of the increase, while the latter contributed only 67,506 horsepower.

In the manufacture of cotton goods, in which there has been a large increase in the use of power during the past thirty years, steam has increased far more rapidly than water. From 1890 to 1900 the amount of power increased from 464,881 to 811,347 horsepower, a gain of 346,466, or 74.5 per cent. In this increase steam figured to the extent of 266,102 horsepower, while water represented 52,868 horsepower. The large increase from 1890 to 1900 in other forms of power used in the cotton manufacture is worthy of note, as these, which were only 390 horsepower in 1890, amounted to 27,886 horsepower in 1900, a gain of 27,496. The classification of "other power" consisted chiefly of

electrical power, the use of which, as noted elsewhere, has increased in this industry very rapidly during the past ten years.

Table VII is of interest in this connection, as it shows, for the industries embraced in the preceding table, the amount and proportion of steam, water, and other power used in 1880, 1890, and 1900. Considered with table VI, the figures show very clearly the changes in the use of power in the principal manufactures during the past twenty years.

TABLE VII.—TOTAL HORSEPOWER AND PER CENT OF STEAM, WATER, AND OTHER POWER FOR SELECTED INDUSTRIES: 1880 TO 1900.

INDUSTRIES.	1900											
	Total horsepower.	Steam power.		Waterpower.		All other power.		1890				
		Total.	Per cent.	Total.	Per cent.	Total.	Per cent.	Total horsepower.	Steam power.		Waterpower.	
									Total.	Per cent.	Total.	Per cent.
All industries	11,300,081	8,742,416	77.4	1,727,258	15.3	830,407	7.4	5,954,655	4,662,029	78.3	1,263,343	21.2
Agricultural implements	77,189	61,147	79.2	6,758	8.8	9,284	12.0	50,395	40,673	80.7	9,667	19.2
Boots and shoes, factory product	51,073	34,816	68.2	2,390	4.7	13,867	27.2	30,686	27,885	90.9	1,874	6.1
Cotton goods[1]	811,347	531,611	65.5	251,850	31.1	27,886	3.4	464,881	265,509	57.1	198,982	42.8
Flouring and grist mill products	1,016,859	533,755	52.5	451,378	44.4	31,726	3.1	752,365	366,587	48.7	383,872	51.0
Hosiery and knit goods	58,087	39,693	68.3	14,824	25.5	3,570	6.2	34,538	22,005	63.7	12,360	35.8
Iron and steel	1,670,547	1,581,695	94.7	8,649	0.5	80,203	4.8	745,824	737,771	98.9	8,053	1.1
Lumber and timber products	1,613,747	1,401,883	86.9	200,983	12.5	10,881	0.7	961,316	759,078	79.0	201,651	21.0
Paper and wood pulp	764,847	255,854	33.5	504,762	66.0	4,231	0.6	297,724	93,659	31.5	203,896	68.4
Silk and silk goods	61,395	45,959	74.7	6,666	10.9	8,770	14.3	29,638	24,427	82.4	4,864	16.4
Woolen goods	139,645	82,933	59.4	52,358	37.5	4,354	3.1	122,501	67,195	54.9	55,030	44.9
Worsted goods	97,383	73,180	75.2	20,491	21.0	3,712	3.8	57,111	44,458	77.8	12,437	21.8
All other industries	4,937,962	4,099,890	83.0	206,149	4.2	631,923	12.8	2,407,676	2,212,782	91.9	170,657	7.1

INDUSTRIES.	1890					1880				
	All other power.		Total horsepower.	Steam power.		Waterpower.				
	Total.	Per cent.		Total.	Per cent.	Total.	Per cent.			
All industries	29,283	0.5	3,410,887	2,185,458	64.1	1,225,879	35.9			
Agricultural implements	55	0.1	44,731	32,086	71.7	12,645	28.3			
Boots and shoes, factory product	927	3.0	11,574	11,164	96.5	410	3.5			
Cotton goods[1]	390	0.1	275,504	126,750	46.0	148,754	54.0			
Flouring and grist mill products	1,906	0.3	771,201	301,214	39.1	469,987	60.9			
Hosiery and knit goods	173	0.5	11,561	6,069	52.5	5,492	47.5			
Iron and steel	.....	.....	397,427	380,741	95.8	16,506	4.2			
Lumber and timber products	587	0.1	821,928	543,242	66.1	278,686	33.9			
Paper and wood pulp	169	0.1	123,912	36,301	29.3	87,611	70.7			
Silk and silk goods	347	1.2	8,810	7,248	82.3	1,562	17.7			
Woolen goods	276	0.2	106,507	52,897	49.7	53,610	50.3			
Worsted goods	216	0.4	16,437	10,135	61.7	6,302	38.3			
All other industries	24,237	1.0	821,245	677,611	82.5	143,814	17.5			

[1] Includes cotton small wares.

An analysis of the statistics of power for the different census periods, considered in relation to the number of wage-earners employed and the value of products, shows very strikingly the extent to which, in the larger industries, mechanical power has been substituted for hand labor, or hand-operated machines.

Table VIII shows the total horsepower employed from 1870 to 1900 in a few of the larger industries, the percentage of increase, the average number of wage-earners employed, the amount of power used per wage-earner, the value of products, and the horsepower per $1,000 of products.

TABLE VIII.—TOTAL HORSEPOWER IN SELECTED INDUSTRIES, WITH PER CENT OF INCREASE, POWER PER WAGE-EARNER, AND PER $1,000 OF PRODUCTS: 1870 TO 1900.

SELECTED INDUSTRIES.	Year.	Amount of horse-power.	Per cent of increase in total horse-power.	Average number of wage-earners.	Power per wage-earner.	Value of products.	Horse-power per $1,000 of products.
Agricultural implements	1900	77,189	53.2	46,582	1.7	$101,207,428	0.8
	1890	50,395	12.7	38,827	1.3	81,271,651	0.6
	1880	44,731	71.5	39,580	1.1	68,640,486	0.7
	1870	26,082	.....	25,249	1.0	52,066,875	0.5
Boots and shoes, factory product	1900	51,073	66.4	142,922	0.4	261,028,580	0.2
	1890	30,686	165.1	133,690	0.2	220,649,358	0.1
	1880	11,574	278.9	111,152	0.1	166,050,354	0.1
	1870	3,055	.....	91,702	(1)	146,704,055	(1)
Cotton goods[2]	1900	811,347	74.5	302,861	2.7	339,200,320	2.4
	1890	464,881	68.7	218,876	2.1	267,981,724	1.7
	1880	275,504	88.7	185,472	1.5	210,950,383	1.3
	1870	146,040	.....	135,519	1.1	177,489,739	0.8
Flouring and grist mill products	1900	1,016,859	35.2	37,073	27.4	560,719,063	1.8
	1890	752,365	[3]2.5	47,403	15.9	513,971,474	1.5
	1880	771,201	33.7	58,407	13.2	505,185,712	1.5
	1870	576,686	.....	58,448	9.9	444,985,143	1.3
Hosiery and knit goods	1900	58,087	68.2	83,387	0.7	95,482,566	0.6
	1890	34,538	198.8	59,588	0.6	67,241,013	0.5
	1880	11,561	77.9	28,885	0.4	29,167,227	0.4
	1870	6,498	.....	14,788	0.4	18,411,564	0.4
Iron and steel	1900	1,670,547	124.0	226,161	7.4	835,759,034	2.0
	1890	745,824	87.8	148,715	5.0	478,687,519	1.6
	1880	397,247	132.8	140,978	2.8	296,557,685	1.3
	1870	170,675	.....	77,555	2.2	307,208,696	0.6
Lumber and timber products	1900	1,613,747	67.9	283,260	5.7	566,832,984	2.9
	1890	961,316	17.0	311,964	3.1	437,957,382	2.2
	1880	821,928	28.1	147,956	5.6	238,268,729	3.5
	1870	641,665	.....	149,997	4.3	210,159,327	3.1
Paper and wood pulp	1900	764,847	156.9	49,646	15.4	127,286,162	6.0
	1890	297,724	140.3	31,050	9.6	78,937,184	3.1
	1880	[4]123,912	128.3	25,631	4.8	55,109,914	2.3
	1870	54,287	.....	18,021	3.0	50,842,445	1.1
Silk and silk goods	1900	61,395	107.2	65,416	0.9	107,256,258	0.6
	1890	29,638	236.4	49,382	0.6	87,298,454	0.3
	1880	8,810	361.0	31,337	0.3	41,033,045	0.2
	1870	1,911	.....	6,099	0.3	12,210,662	0.2
Woolen goods	1900	139,645	14.0	69,350	2.0	120,038,702	1.2
	1890	122,501	15.0	76,915	1.6	133,577,977	0.9
	1880	106,507	25.2	86,504	1.2	160,606,721	0.7
	1870	85,101	.....	77,870	1.1	155,405,358	0.6
Worsted goods	1900	97,383	69.9	56,551	1.7	118,705,710	0.8
	1890	57,111	247.5	42,978	1.3	79,194,652	0.7
	1880	16,437	105.1	18,803	0.9	33,549,942	0.5
	1870	8,016	.....	12,920	0.6	22,090,331	0.4

[1] Less than one-tenth of 1 per cent.
[2] Includes cotton small wares.
[3] Decrease.
[4] Horsepower exclusive of "wood pulp," for which figures were not accessible.

These figures show, in nearly every case, a continuous increase during the past thirty years in the power per wage-earner and also in the power required for $1,000 of products. It might be assumed that this showing indicated a decrease in mechanical efficiency, or the requirement of much more power to operate the machinery, were it not too obvious to require proof that in nearly every important industry there has been a continuous substitution of power-driven machinery for hand labor, with a consequent increase in the amount of power required and at the same time an increase in the productive capacity of each operative.

Any calculation of the ratio of power to product in different years should take into consideration the continuous decline in the value of products. If it were possible to measure the output of each industry by units of quantity rather than value, there would not appear to be any such large increase in the amount of power required as is indicated by these figures.

Possibly the most striking increase in the use of power shown in this table is in connection with the manufacture of boots and shoes. In 1870 there were reported for this industry 3,055 horsepower and 91,702 wage-earners, or only three-hundredths of a horsepower per wage-earner; while in 1900 there were 51,073 horsepower and 142,922 wage-earners, or four-tenths of a horsepower per wage-earner. The increase in horsepower per $1,000 of products was from two-hundredths to two-tenths of a horsepower. This is a more striking showing of the displacement of hand labor by power-driven machinery than is furnished by any other of the large industries. It is worthy of note that the increase in the value of products per wage-earner in the boot and shoe manufacture from 1870 to 1900, with this

very large increase in the use of power, was from $1,600 to $1,826, without making allowance for the very large decrease in the value per unit of product, that is, in the selling price during the thirty years.

In contrast with the small amount of power per wage-earner and per $1,000 of products in the boot and shoe industry is the showing of the paper and pulp mills. The very heavy power requirements of the pulp grinders and the comparatively small number of wage-earners required for them show a high proportion of power to wage-earner, or 15.4 horsepower for each wage-earner in 1900 compared with 3 horsepower in 1870. Again, the enormous power requirements of this industry, with the comparatively low price of the products, show a larger amount of power required per $1,000 of products than in any other large industry. In 1900 it required 6 horsepower to produce $1,000 in value of wood pulp and paper, compared with 1.1 horsepower in 1870.

The relations between power and labor, and between power and product appear to have been more nearly stationary in the manufacture of lumber and timber products during the past thirty years than in any other of the more important manufactures. While the amount of power per wage-earner in this industry appears to have increased from 4.3 horsepower to only 5.7 horsepower in thirty years, there has been an actual decrease in the amount of power required per $1,000 of products, which was only 2.9 horsepower in 1900, compared with 3.1 horsepower in 1870. In spite of this very small increase in the amount of power per wage-earner, the value of products per wage-earner increased from $1,401 in 1870 to $2,001 in 1900, and this with an actual decrease in the ratio of power to product.

The iron and steel industry, the largest user of power, shows an increase in thirty years from 2.2 horsepower per wage-earner to 7.4 horsepower. The increase in horsepower per $1,000 of products during the same period was in about the same ratio; namely, from six-tenths of a horsepower in 1870 to 2 horsepower in 1900.

In the manufacture of cotton goods the amount of horsepower per wage-earner has increased in thirty years from 1.1 to 2.7, while during the same time the amount of horsepower per $1,000 of products has increased from eight-tenths to 2.4 horsepower.

VIII.

STATISTICS OF POWER BY STATES AND TERRITORIES.

Table IX shows the total horsepower used in manufactures in each of the states and territories in 1870, 1880, 1890, and 1900, with the amount and percentage of increase during each of the three decades.

TABLE IX.—POWER USED IN MANUFACTURES, BY STATES AND TERRITORIES, 1870 TO 1900, WITH THE AMOUNT AND PER CENT OF INCREASE FOR EACH DECADE.

STATES AND TERRITORIES.	TOTAL HORSEPOWER.				INCREASE.					
					1890 to 1900.		1880 to 1890.		1870 to 1880.	
	1900	1890	1880	1870	Amount.	Per cent.	Amount.	Per cent.	Amount.	Per cent.
United States	11,300,081	5,954,655	3,410,837	2,346,142	5,345,426	89.8	2,543,818	74.6	1,064,695	45.4
Alabama	225,146	102,333	27,576	18,751	122,813	120.0	74,757	271.1	8,825	47.1
Alaska	1,962	451	.....	.....	1,511	335.0	451	.....	.....	.....
Arizona	9,110	826	530	90	8,284	1,002.9	296	55.9	440	488.9
Arkansas	120,470	38,344	15,733	7,646	82,126	214.2	22,611	143.7	8,087	105.8
California	134,366	73,324	32,921	25,370	61,042	83.3	40,403	122.7	7,551	29.8
Colorado	45,150	32,734	5,802	2,225	12,416	37.9	26,932	464.2	3,577	160.8
Connecticut	270,281	163,233	118,232	80,374	107,048	65.6	45,001	38.1	37,858	47.1
Dakota	(1)	(1)	2,224	324	.....	.....	6,920	311.1	1,900	586.4
Delaware	42,560	26,516	15,428	8,533	16,044	60.5	11,088	71.9	6,895	80.8
District of Columbia	10,509	11,444	3,143	1,889	[2]935	[2]8.2	8,301	264.1	1,254	66.4
Florida	40,745	16,058	7,147	3,700	24,687	153.7	8,911	124.7	3,447	93.2
Georgia	189,706	84,221	51,169	38,243	105,485	125.3	33,052	64.6	12,926	33.8
Idaho	6,502	2,001	1,682	606	4,501	224.9	319	19.0	1,076	177.6
Illinois	615,655	286,666	144,288	86,044	328,989	114.8	142,378	98.7	58,244	67.7
Indiana	352,789	190,898	131,770	100,369	161,891	84.9	59,128	44.9	31,401	31.3
Indian Territory	12,690	424	.....	.....	12,266	2,892.9	424	.....	.....	.....
Iowa	125,529	77,809	54,221	39,547	47,720	61.3	23,588	43.5	14,674	37.1
Kansas	74,391	43,053	21,079	8,149	31,338	72.8	21,974	104.3	12,930	158.7
Kentucky	165,140	82,508	54,929	39,568	82,632	100.1	27,579	50.2	15,361	38.8
Louisiana	217,125	30,184	11,346	25,066	186,941	619.3	18,838	166.0	[2]13,720	[2]54.7
Maine	271,547	150,508	100,476	79,573	121,039	80.4	50,032	49.8	20,903	26.3
Maryland	141,879	73,547	51,259	32,422	68,332	92.9	22,288	43.5	18,837	58.1
Massachusetts	824,104	517,897	309,759	184,356	306,207	59.1	208,138	67.2	125,403	68.0
Michigan	397,122	256,608	164,747	105,851	140,514	54.8	91,861	55.8	58,896	55.6
Minnesota	191,201	112,817	53,880	20,139	78,384	69.5	58,937	109.4	33,741	167.5

[1] See North Dakota and South Dakota.

TABLE IX.—POWER USED IN MANUFACTURES, BY STATES AND TERRITORIES, 1870 TO 1900, WITH THE AMOUNT AND PER CENT OF INCREASE FOR EACH DECADE—Continued.

STATES AND TERRITORIES.	TOTAL HORSEPOWER.				INCREASE.					
					1890 to 1900.		1880 to 1890.		1870 to 1880.	
	1900	1890	1880	1870	Amount.	Per cent.	Amount.	Per cent.	Amount.	Per cent.
Mississippi	124,254	35,331	18,450	12,472	88,923	251.7	16,881	91.5	5,978	47.9
Missouri	218,372	145,185	80,749	55,062	73,187	50.4	64,436	79.8	25,687	46.7
Montana	46,981	2,848	1,498	1,617	44,133	1,549.6	1,350	90.1	[1]119	[1]7.4
Nebraska	45,756	23,479	8,494	3,311	22,277	94.9	14,985	176.4	5,183	156.5
Nevada	1,625	372	716	8,545	1,253	336.8	[2]344	[1]48.0	[1]7,829	[1]91.6
New Hampshire	211,221	116,830	87,750	77,078	94,391	80.8	29,080	33.1	10,672	13.9
New Jersey	341,394	180,529	99,858	58,139	160,865	89.1	80,671	80.8	41,719	71.8
New Mexico	4,360	1,825	1,359	911	2,535	138.9	466	34.3	448	49.2
New York	1,181,369	776,820	454,143	334,363	404,549	52.1	322,677	71.1	119,780	35.8
North Carolina	208,297	78,345	45,088	33,152	129,952	177.2	28,257	62.7	11,936	36.0
North Dakota	8,392	3,589	([2])	([2])	4,803	133.8	.....	.....	.....	.....
Ohio	850,600	418,783	261,143	174,323	431,817	103.1	157,640	60.4	86,820	49.8
Oklahoma	9,335	161	.....	.....	9,174	5,698.1	161	.....	.....	.....
Oregon	63,767	32,545	13,589	8,277	31,222	95.9	18,956	139.5	5,312	64.2
Pennsylvania	1,859,265	986,789	512,408	363,918	872,476	88.4	474,381	92.6	148,490	40.8
Rhode Island	156,550	112,949	63,575	42,027	43,601	38.6	49,374	77.7	21,548	51.3
South Carolina	146,225	45,681	25,868	14 932	100,544	220.1	19,813	76.6	10,936	73.2
South Dakota	12,611	5,555	([2])	([2])	7,056	127.0	.....	.....	.....	.....
Tennessee	169,350	84,379	51,952	37,981	84,971	100.7	32,427	62.4	13,971	36.8
Texas	240,133	68,530	30,534	13,044	171,603	250.4	37,996	124.4	17,490	134.1
Utah	15,010	5,128	4,689	2,500	9,882	192.7	439	9.4	2,189	87.6
Vermont	138,095	98,554	63,314	51,322	39,541	40.1	35,240	55.7	11,992	23.4
Virginia	171,469	82,448	57,174	49,612	89,021	108.0	25,274	44.2	7,562	15.2
Washington	88,802	42,642	4,395	2,823	46,160	108.3	38,247	870.2	1,572	55.7
West Virginia	108,566	55,457	37,910	27,331	53,109	95.8	17,547	46.3	10,579	38.7
Wisconsin	393,268	178,668	106,085	64,223	214,600	120.1	72,583	68.4	41,862	65.2
Wyoming	4,335	1,829	755	344	2,506	137.0	1,074	142.3	411	119.5

[1] Decrease. [2] See Dakota.

There is striking evidence of continuous progression in the manufacturing industries in the fact that, during the decade from 1870 to 1880, in only 3 states was there any decrease. From 1880 to 1890, in only one instance was there any decrease in the amount of power used, and that was so small as to be of no significance. During the decade ending with the census year 1900, the only decrease in the amount of power used in manufactures was in the District of Columbia, which is without any particular significance from an industrial standpoint, as the District of Columbia does not rank as one of the prominent manufacturing centers of the country.

The largest increase in power in the past decade was in the state of Pennsylvania, which in 1890 reported 986,789 horsepower, and in 1900 a total of 1,859,265 horsepower, showing an increase in the ten years of 872,476 horsepower, or 88.42 per cent. This increase is more than twice as large as the gain in the next largest state—Ohio—which showed an increase during the decade of 431,817 horsepower.

The very large increase in horsepower in Pennsylvania was due to the great development of the iron and steel industry between 1890 and 1900, which more than doubled its motive power during that period, the increase being from 404,871 to 840,616, showing a gain of 435,745. This industry thus accounts for one-half of the total increase in power reported for Pennsylvania. Other industries which contributed largely to the increase were the lumber and woodworking industries, which showed an increase of 27,516 horsepower; the paper and pulp industry, which showed a gain of 19,537 horsepower; and the silk industry, showing an increase of 19,270 horsepower. A large number of minor industries, all of them showing a considerable increase, make up the remainder of the very large gain which Pennsylvania shows.

In Ohio, also, the iron and steel industry accounts for more than one-half of the increase in power during the last decade. Out of a total increase of 431,817 horsepower, the iron and steel industry represents 225,677 horsepower. The lumber and woodworking industries show an increase of 23,952 horsepower, and the flouring and grist mill industry gained 13,526 horsepower in the ten years. The large expansion of the industries using iron and steel is shown by the increase in the amount of power used by the foundries and machine

shops of Ohio, which in 1900 reported a total of 53,928 horsepower, as compared with 23,292 horsepower in 1890, an increase of 30,636.

New York shows an increase of 404,549 horsepower from 1890 to 1900. The largest item of this increase is represented by the paper and pulp industry, in which there has been a very striking development during the past ten years, based upon large areas of pulp wood and an abundance of waterpower, which has been utilized to a very large extent. In 1890 the manufacture of paper and wood pulp in the state of New York employed 75,870 horsepower, while for this industry there was reported in 1900 a total of 228,478 horsepower, showing an increase of 152,608 horsepower, or more than one-third of the total increase in the state. The lumber and woodworking industries show an increase of 23,453 horsepower, and the chemical industries an increase of 22,219 horsepower. The remainder of the increase is made up by a large number of small industries.

Illinois shows an increase in the amount of power used in manufactures amounting to 328,989 from 1890 to 1900. The largest items in this increase are a gain of 81,565 horsepower in the iron and steel industry, and 19,265 horsepower in foundries and machine shops.

Massachusetts shows an increase of 306,207 horsepower in the ten years, the larger portion of which represents the growth of a few of the leading industries. The manufacture of cotton goods contributed the largest increase during the decade, viz., from 171,924 horsepower in 1890 to 281,032 horsepower in 1900, a gain of 109,108 horsepower. Next to this was the paper and pulp industry, which increased its power requirements of 44,836 in 1890 to 82,893 horsepower in 1900, a gain of 38,057 horsepower. While the woolen industry of Massachusetts shows an increase of only 1,674 horsepower in 1900, as compared with 1890, the worsted industry shows an increase from 16,835 to 38,611, a gain of 21,776 horsepower. The remainder of the increase in Massachusetts is distributed over a large number of industries, all of which have contributed their quota to the large gain in the aggregate of motive power used by the manufacturing establishments of the state.

A striking illustration of the influence of a single industry is shown in the large increase in the amount of power used in the state of Louisiana, which in 1890 amounted to 30,184 horsepower, while in 1900 a total of 217,125 horsepower was reported. Examination of the detailed statistics by industries shows that the sugar-refining industry in Louisiana, for which in 1890 was reported a total of only 3,578 horsepower, returned in 1900 a total of 120,277 horsepower, a gain of 116,699 horsepower in a single industry.

IX.

STATISTICS OF POWER BY GEOGRAPHIC DIVISIONS.

Table x shows the total horsepower and the percentage of steam, water, and other power in the different groups of states in the years 1870, 1880, 1890, and 1900.

TABLE X.—TOTAL HORSEPOWER AND PER CENT OF STEAM, WATER, AND OTHER POWER, BY GEOGRAPHIC DIVISIONS: 1870 TO 1900.

GEOGRAPHIC DIVISIONS.	1900							1890						
	Total horsepower.	Steam power.		Waterpower.		All other power.		Total horsepower.	Steam power.		Waterpower.		All other power.	
		Total.	Per cent.	Total.	Per cent.	Total.	Per cent.		Total.	Per cent.	Total.	Per cent.	Total.	Per cent.
United States	11,300,081	8,742,416	77.4	1,727,258	15.3	830,407	7.3	5,954,655	4,662,029	78.3	1,263,343	21.2	29,283	0.5
New England states	1,871,798	1,101,128	58.8	655,931	35.0	114,739	6.1	1,159,971	654,039	56.4	501,629	43.3	4,303	0.4
Middle states	3,576,976	2,732,639	76.4	500,111	14.0	344,226	9.6	2,055,645	1,690,144	82.2	355,088	17.3	10,413	0.5
Southern states	2,143,651	1,831,649	85.4	256,122	11.9	55,880	2.6	799,404	632,052	79.1	163,803	20.5	2,949	0.4
Central states	3,144,536	2,649,642	84.3	240,659	7.7	254,235	8.1	1,667,434	1,457,045	87.4	200,941	12.1	9,448	0.6
Western states	274,223	203,401	74.2	39,938	14.6	30,884	11.3	123,239	100,027	81.2	22,279	18.1	933	0.8
Pacific states	286,935	222,879	77.7	33,900	11.8	30,156	10.5	148,511	127,882	86.1	19,442	13.1	1,237	0.8
Outlying districts	1,962	1,078	54.9	597	30.4	287	14.6	451	290	64.3	161	35.7	.....	.....

GEOGRAPHIC DIVISIONS.	1880					1870				
	Total horsepower.	Steam power.		Waterpower.		Total horsepower.	Steam power.		Waterpower.	
		Total.	Per cent.	Total.	Per cent.		Total.	Per cent.	Total.	Per cent.
United States	3,410,837	2,185,458	64.1	1,225,379	35.9	2,346,142	1,215,711	51.8	1,130,431	48.2
New England states	743,106	320,201	43.1	422,905	56.9	514,730	152,704	29.7	362,026	70.3
Middle states	1,136,239	755,841	66.5	380,398	33.5	799,264	399,413	50.0	399,851	50.0
Southern states	434,876	265,572	61.1	169,304	38.9	321,498	161,415	50.2	160,083	49.8
Central states	996,883	782,022	78.3	214,861	21.5	645,558	461,785	71.5	183,773	28.5
Western states	48,828	26,207	53.7	22,621	46.3	28,622	18,019	63.0	10,603	37.0
Pacific states	50,905	35,615	70.0	15,290	30.0	36,470	22,375	61.3	14,095	38.7
Outlying districts	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Within the past twenty years there have been some significant changes in the relative positions of steam power and waterpower in different sections of the country. In nearly all of the Atlantic Coast states, in 1870, waterpower was used to as great an extent as steam, and in some even more largely. In New England in 1870, 70.3 per cent of the power used for manufacturing purposes was furnished by water; and in the Middle and Southern states waterpower figured to the extent of one-half of the total in those sections. In thirty years there has been a marked change in these conditions. In New England in 1900 waterpower was only 35 per cent of the total, as compared with twice that ratio in 1870. In the Middle states waterpower had fallen from 50 per cent to 14 per cent; and in the Southern states only 11.9 per cent of the power used was derived from water in 1900 as compared with 49.8 per cent in 1870. In no section of the country is the use of waterpower so large as in New England, and this has been characteristic of that section of the country for many years.

It is worthy of note that in the Middle, Central, Western, and Pacific states both steam power and waterpower constitute a smaller percentage of the total power used in manufacturing in those sections than in 1890, this change being due to the larger amount of power returned under the heading of "all other power," which for the most part consists of electric power, very largely supplied from generators driven by water.

X.

RENTED POWER.

Table XI shows the amount of rented power used by manufacturing establishments in 1890 and 1900, by states and territories.

TABLE XI.—*Power rented: by states and territories, 1890 and 1900.*

STATES AND TERRITORIES.	1900	1890
United States	321,051	88,571
Alabama	824	283
Arizona	38	40
Arkansas	281	160
California	12,315	2,593
Colorado	1,539	276
Connecticut	9,242	3,098
Delaware	1,522	104
District of Columbia	771	51
Florida	162	13
Georgia	2,025	457
Idaho	6	.....
Illinois	27,096	6,753
Indiana	4,474	1,678
Iowa	3,408	190
Kansas	1,605	223
Kentucky	2,450	324
Louisiana	1,593	7
Maine	8,814	2,870
Maryland	2,411	979
Massachusetts	32,009	15,307
Michigan	6,465	1,983
Minnesota	4,772	1,481
Mississippi	541	212
Missouri	8,923	1,597
Montana	1,259	17
Nebraska	1,217	179
Nevada	1	.....
New Hampshire	4,426	955
New Jersey	10,112	3,562
New Mexico	8	10
New York	82,944	25,723
North Carolina	1,522	87
North Dakota	154	27
Ohio	16,649	5,880
Oklahoma	65	.....
Oregon	2,561	490
Pennsylvania	38,359	6,927
Rhode Island	6,691	1,911
South Carolina	3,621	74
South Dakota	120	.....
Tennessee	1,950	217
Texas	2,672	124
Utah	1,603	32
Vermont	3,158	844
Virginia	1,791	193
Washington	2,752	16
West Virginia	285	75
Wisconsin	3,838	549
Wyoming	7	.....

The very large increase in the amount of rented power used in manufacturing establishments, as shown by table XI, from a total of 88,571 in 1890 to 321,051 horsepower in 1900, is one of the significant features of the recent developments in the use of power. As the figures for 1890 distinguish only between rented steam power and waterpower, and as the figures for 1900 divide rented power into electric and other kinds, it is not possible to make any comparisons except between the totals for the United States and for different states at the two census periods. In 1890 the distribution of electric power from central stations and its rental to manufacturing establishments had not assumed sufficient importance to call for any special consideration. Such electric power as was in use in 1890 was utilized mainly in the establishments in which it was generated. In 1890 nearly all of the rented power was derived from steam, representing 80,434, out of a total of 88,571 rented horsepower. In 1900, however, electric power represented 183,682 horsepower, out of a total of 321,051 rented horsepower, leaving 137,369 horsepower to cover steam, water, and other forms of rented power.

It appears from the preceding table that the use of rented power is largest in the great cities of the country, as the largest amount of rented power is reported, both in 1890 and 1900, for New York, Pennsylvania, Massachusetts, and Illinois. The use of rented power naturally centers in the cities of New York, Philadelphia, Boston, and Chicago, and in lesser proportion in the other large cities, for in these cities there are numerous small industries which are operated by motive power supplied either by other manufacturing establishments in their immediate vicinity, or by electric current from central stations. The use of rented power is confined mainly to the large cities and to the smaller industries, with the exception of a few isolated cases like the great power development at Niagara Falls, where electric power is furnished in large quantities to industries which are located in the immediate vicinity. The rental of power follows two lines of development; it is distributed in small quantities to minor industries in the large cities, and in large amounts to industries grouped about large waterpowers, the energy of which is transmitted by electrical current.

XI.

COMPARATIVE STATISTICS, 1870 TO 1900.

Table XII shows the amounts and kinds of power used in each state and territory, in the years 1870, 1880, 1890, and 1900.

Table XIII shows the percentage that the total horsepower of each state and territory is of the total for the United States, and that steam, water, and other power are of the total for each state and territory for 1870, 1880, 1890, and 1900.

The detailed statistics of power used in manufactures for 1900 are presented in General Tables Nos. 10, 11, and 12 in this volume, pages 582 to 631.

TABLE XII.—AMOUNT OF EACH KIND OF POWER, BY STATES AND TERRITORIES: 1870 TO 1900, INCLUSIVE.

STATES AND TERRITORIES.	Year.	NUMBER OF ESTABLISHMENTS.		Total horsepower.	OWNED.										RENTED.		
					Engines.				Water wheels.		Electric motors.		Other power.		To this establishment.		By this establishment.
					Steam.		Gasorgasoline.										
		Total.	Reporting power.		Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Electric horsepower.	All other horsepower.	
United States	1900	512,254	169,409	11,300,081	156,100	8,742,416	14,864	143,850	39,182	1,727,258	16,923	311,016	2,144	54,490	183,682	137,869	54,012
	1890	355,415	100,735	5,954,655	91,410	4,581,595	(1)	8,930	39,008	1,255,206	(1)	15,569	(1)	4,784	.....	88,571	.....
	1880	253,852	85,923	3,410,837	56,483	2,185,458	.....	.....	55,404	1,225,379	.....	.....	.....	.....	.....	.....	.....
	1870	252,148	(2)	2,346,142	(2)	1,215,711	.....	.....	(2)	1,130,431	.....	.....	.....	.....	.....	.....	.....
Alabama	1900	5,602	3,659	225,146	3,427	199,220	47	485	1,023	21,293	70	3,069	19	255	404	420	317
	1890	2,977	1,634	102,333	1,373	91,583	(1)	14	764	10,382	(1)	51	(1)	20	.....	283	.....
	1880	2,070	1,257	27,576	551	15,779	.....	.....	931	11,797	.....	.....	.....	.....	.....	.....	.....
	1870	2,188	(2)	18,751	(2)	7,740	.....	.....	(2)	11,011	.....	.....	.....	.....	.....	.....	.....
Alaska	1900	63	45	1,962	49	1,078	.....	.....	14	597	11	287	.....	.....	.....	.....	.....
	1890	10	9	451	7	290	.....	.....	3	161	.....	.....	.....	.....	.....	.....	.....
	[3]1880	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	[3]1870	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Arizona	1900	314	91	9,110	132	7,688	19	371	10	442	30	496	1	75	38	.....	.....
	1890	76	21	826	16	457	.....	.....	8	329	.....	.....	.....	.....	.....	40	.....
	1880	66	21	530	14	370	.....	.....	8	160	.....	.....	.....	.....	.....	.....	.....
	1870	18	(2)	90	(2)	80	.....	.....	(2)	10	.....	.....	.....	.....	.....	.....	.....
Arkansas	1900	4,794	3,031	120,470	3,221	116,291	44	451	188	2,940	17	279	4	228	211	70	44
	1890	2,073	1,140	38,344	1,172	36,365	(1)	7	119	1,778	(1)	31	(1)	3	.....	160	.....
	1880	1,202	729	15,733	545	13,709	.....	.....	149	2,024	.....	.....	.....	.....	.....	.....	.....
	1870	1,079	(2)	7,646	(2)	6,101	.....	.....	(2)	1,545	.....	.....	.....	.....	.....	.....	.....
California	1900	12,582	3,077	134,366	2,183	105,857	548	3,283	194	5,164	281	6,138	91	1,609	9,699	2,616	1,054
	1890	7,923	1,614	73,324	1,481	64,864	(1)	361	190	5,091	(1)	393	(1)	22	.....	2,593	.....
	1880	5,885	1,000	32,921	779	28,071	.....	.....	205	4,850	.....	.....	.....	.....	.....	.....	.....
	1870	3,984	(2)	25,370	(2)	18,493	.....	.....	(2)	6,877	.....	.....	.....	.....	.....	.....	.....
Colorado	1900	3,570	829	45,150	830	40,299	82	524	64	1,596	40	709	14	488	1,187	352	110
	1890	1,518	399	32,734	457	30,641	(1)	36	47	1,723	(1)	58	.....	.....	.....	276	.....
	1880	599	181	5,802	152	3,953	.....	.....	52	1,849	.....	.....	.....	.....	.....	.....	.....
	1870	256	(2)	2,225	(2)	1,433	.....	.....	(2)	792	.....	.....	.....	.....	.....	.....	.....
Connecticut	1900	9,128	2,874	270,281	2,729	178,708	178	1,712	1,294	71,414	442	8,710	42	495	4,215	5,027	2,156
	1890	6,822	2,185	163,233	1,794	96,178	(1)	215	1,365	63,417	(1)	205	(1)	120	.....	3,098	.....
	1880	4,488	2,028	118,282	1,124	57,027	.....	.....	1,784	61,205	.....	.....	.....	.....	.....	.....	.....
	1870	5,128	(2)	80,374	(2)	25,979	.....	.....	(2)	54,395	.....	.....	.....	.....	.....	.....	.....
Dakota	[3]1900	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	[3]1890	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	1880	251	79	2,224	55	1,421	.....	.....	36	803	.....	.....	.....	.....	.....	.....	.....
	1870	17	(2)	324	(2)	248	.....	.....	(2)	76	.....	.....	.....	.....	.....	.....	.....
Delaware	1900	1,417	542	42,560	656	33,100	36	335	177	6,326	188	1,277	.....	.....	605	917	154
	1890	1,003	311	26,516	398	21,556	(1)	80	163	4,671	(1)	104	(1)	1	.....	104	.....
	1880	746	317	15,428	254	10,643	.....	.....	232	4,785	.....	.....	.....	.....	.....	.....	.....
	1870	800	(2)	8,533	(2)	4,313	.....	.....	(2)	4,220	.....	.....	.....	.....	.....	.....	.....
Dist. of Columbia	1900	2,669	324	10,509	241	8,630	53	344	5	369	29	248	23	147	100	671	69
	1890	2,295	197	11,444	246	10,422	(1)	91	9	810	(1)	70	.....	.....	.....	51	.....
	1880	971	115	3,143	118	2,263	.....	.....	15	880	.....	.....	.....	.....	.....	.....	.....
	1870	952	(2)	1,889	(2)	789	.....	.....	(2)	1,100	.....	.....	.....	.....	.....	.....	.....
Florida	1900	2,056	816	40,745	1,005	38,267	35	218	91	1,102	8	140	48	861	162	.....	3
	1890	805	368	16,058	460	15,479	(1)	63	45	496	(1)	3	.....	4	.....	13	.....
	1880	426	244	7,147	193	6,208	.....	.....	70	939	.....	.....	.....	.....	.....	.....	.....
	1870	659	(2)	3,700	(2)	3,172	.....	.....	(2)	528	.....	.....	.....	.....	.....	.....	.....
Georgia	1900	7,504	4,453	189,706	3,811	144,855	51	431	1,550	40,337	48	1,065	13	493	1,728	297	293
	1890	4,285	2,002	84,221	1,565	55,082	(1)	119	1,121	28,380	(1)	157	(1)	26	.....	457	.....
	1880	3,593	2,074	51,169	799	21,102	.....	.....	1,917	30,067	.....	.....	.....	.....	.....	.....	.....
	1870	3,886	(2)	38,243	(2)	10,826	.....	.....	(2)	27,417	.....	.....	.....	.....	.....	.....	.....
Idaho	1900	591	211	6,502	161	4,506	7	48	72	1,942	.....	.....	.....	.....	6	.....	.....
	1890	140	64	2,001	33	972	.....	.....	32	1,024	(1)	2	(1)	3	.....	.....	.....
	1880	162	67	1,682	22	546	.....	.....	48	1,136	.....	.....	.....	.....	.....	.....	.....
	1870	101	(2)	606	(2)	311	.....	.....	(2)	295	.....	.....	.....	.....	.....	.....	.....
Illinois	1900	38,360	9,193	615,655	7,661	524,555	1,343	9,642	319	13,175	1,840	36,779	128	4,408	12,471	14,625	3,240
	1890	20,482	4,913	286,666	4,967	261,865	(1)	708	446	15,992	(1)	939	(1)	409	.....	6,753	.....
	1880	14,549	3,722	144,288	3,445	126,843	.....	.....	751	17,445	.....	.....	.....	.....	.....	.....	.....
	1870	12,597	(2)	86,044	(2)	73,091	.....	.....	(2)	12,953	.....	.....	.....	.....	.....	.....	.....
Indiana	1900	18,015	6,272	352,789	6,498	314,776	820	12,600	492	15,510	378	5,139	26	290	2,794	1,680	954
	1890	12,354	4,292	190,898	4,523	172,506	(1)	176	698	16,181	(1)	323	(1)	34	.....	1,678	.....
	1880	11,198	4,066	131,770	3,634	109,960	.....	.....	1,143	21,810	.....	.....	.....	.....	.....	.....	.....
	1870	11,847	(2)	100,369	(2)	76,851	.....	.....	(2)	23,518	.....	.....	.....	.....	.....	.....	.....

[1] Not reported separately. [2] Not reported. [3] See North Dakota and South Dakota.

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TABLE XII.—AMOUNT OF EACH KIND OF POWER, BY STATES AND TERRITORIES: 1870 TO 1900, INCLUSIVE—Cont'd.

STATES AND TERRITORIES.	Year.	NUMBER OF ESTABLISHMENTS.		Total horse-power.	OWNED.										RENTED.		
					Engines.				Water wheels.		Electric motors.		Other power.		To this establishment.		By this establishment.
		Total.	Reporting power.		Steam.		Gasorgasoline.								Electric horse-power.	All other horse-power.	
					Number.	Horse-power.	Number.	Horse-power.	Number.	Horse-power.	Number.	Horse-power.	Number.	Horse-power.			
Indian Territory	1900	789	341	12,690	327	12,332	16	55	18	303	.....	.....	.....	.....	.....	.....	.....
	1890	20	11	424	13	349	.....	.....	2	75	.....	.....	.....	.....	.....	.....	.....
	[2]1880	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	[2]1870	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Iowa	1900	14,819	4,528	125,529	3,432	100,606	973	5,326	543	12,159	211	3,609	16	421	2,766	642	538
	1890	7,440	2,051	77,809	1,969	64,697	(2)	70	622	12,618	(2)	194	(2)	40	.....	190	.....
	1880	6,921	1,546	54,221	1,068	33,858	.....	.....	1,093	20,363	.....	.....	.....	.....	.....	.....	.....
	1870	6,666	(1)	39,547	(1)	25,298	.....	.....	(1)	14,249	.....	.....	.....	.....	.....	.....	.....
Kansas	1900	7,830	1,628	74,391	1,427	57,735	387	3,008	281	8,820	105	2,006	53	1,217	1,420	185	16
	1890	4,471	898	43,053	847	34,806	(2)	77	216	7,617	(2)	110	(2)	220	.....	223	.....
	1880	2,803	578	21,079	396	13,468	.....	.....	299	7,611	.....	.....	.....	.....	.....	.....	.....
	1870	1,477	(1)	8,149	(1)	6,360	.....	.....	(1)	1,789	.....	.....	.....	.....	.....	.....	.....
Kentucky	1900	9,560	3,666	165,140	3,661	150,328	141	1,125	572	9,284	114	1,693	12	260	1,732	718	478
	1890	7,745	1,789	82,508	1,896	75,513	(2)	223	337	6,271	(2)	100	(2)	77	.....	324	.....
	1880	5,328	1,767	54,929	1,494	45,917	.....	.....	653	9,012	.....	.....	.....	.....	.....	.....	.....
	1870	5,390	(1)	39,568	(1)	31,928	.....	.....	(1)	7,640	.....	.....	.....	.....	.....	.....	.....
Louisiana	1900	4,350	2,345	217,125	3,982	213,545	77	534	16	333	61	668	21	352	1,401	192	52
	1890	2,613	554	30,184	684	29,439	(2)	213	6	66	(2)	454	(2)	5	.....	7	.....
	1880	1,553	402	11,346	430	11,256	.....	.....	13	90	.....	.....	.....	.....	.....	.....	.....
	1870	2,557	(1)	25,066	(1)	24,924	.....	.....	(1)	142	.....	.....	.....	.....	.....	.....	.....
Maine	1900	6,702	2,377	271,547	1,681	90,751	115	2,405	2,179	167,264	97	2,087	23	226	7,572	1,242	8,698
	1890	5,010	2,022	150,508	965	42,796	(2)	10	2,396	104,602	(2)	191	(2)	39	.....	2,870	.....
	1880	4,481	1,918	100,476	511	20,759	.....	.....	2,887	79,717	.....	.....	.....	.....	.....	.....	.....
	1870	5,550	(1)	79,573	(1)	9,465	.....	.....	(1)	70,108	.....	.....	.....	.....	.....	.....	.....
Maryland	1900	9,879	2,404	141,879	2,808	118,482	339	3,242	551	13,778	229	3,441	8	525	733	1,678	464
	1890	7,485	1,518	73,547	1,287	56,545	(2)	175	583	15,633	(2)	212	(2)	3	.....	979	.....
	1880	6,787	1,532	51,259	914	33,216	.....	.....	1,004	18,043	.....	.....	.....	.....	.....	.....	.....
	1870	5,812	(1)	32,422	(1)	13,961	.....	.....	(1)	18,461	.....	.....	.....	.....	.....	.....	.....
Massachusetts	1900	29,180	8,560	824,104	6,523	579,110	474	4,157	2,342	187,848	823	19,419	116	1,561	13,424	18,585	8,813
	1890	26,928	7,207	517,897	5,084	340,774	(2)	289	2,622	158,932	(2)	2,327	(2)	268	.....	15,307	.....
	1880	14,352	5,173	309,759	3,096	171,397	.....	.....	3,046	133,362	.....	.....	.....	.....	.....	.....	.....
	1870	13,212	(1)	184,356	(1)	78,502	.....	.....	(1)	105,854	.....	.....	.....	.....	.....	.....	.....
Michigan	1900	16,807	5,884	397,122	5,770	332,598	616	6,178	998	42,888	289	7,839	41	1,154	4,344	2,121	1,869
	1890	12,127	4,414	256,608	4,475	214,748	(2)	287	1,218	38,986	(2)	577	(2)	77	.....	1,983	.....
	1880	8,873	3,581	164,747	3,085	130,352	.....	.....	1,746	34,395	.....	.....	.....	.....	.....	.....	.....
	1870	9,455	(1)	105,851	(1)	70,956	.....	.....	(1)	34,895	.....	.....	.....	.....	.....	.....	.....
Minnesota	1900	11,114	3,356	191,201	2,716	152,451	554	4,207	339	26,953	132	2,531	27	287	3,799	978	503
	1890	7,505	1,519	112,317	1,448	83,548	(2)	126	362	27,300	(2)	280	(2)	82	.....	1,481	.....
	1880	3,493	964	53,880	569	25,191	.....	.....	650	28,689	.....	.....	.....	.....	.....	.....	.....
	1870	2,270	(1)	20,139	(1)	7,085	.....	.....	(1)	13,054	.....	.....	.....	.....	.....	.....	.....
Mississippi	1900	4,772	3,224	124,254	3,330	119,770	23	278	239	3,487	16	228	.....	.....	382	159	51
	1890	1,698	985	35,331	926	32,345	(2)	8	252	2,746	(2)	3	(2)	17	.....	212	.....
	1880	1,479	893	18,450	685	15,001	.....	.....	301	3,449	.....	.....	.....	.....	.....	.....	.....
	1870	1,781	(1)	12,472	(1)	10,019	.....	.....	(1)	2,453	.....	.....	.....	.....	.....	.....	.....
Missouri	1900	18,754	5,041	218,372	4,575	191,558	446	3,448	358	6,748	598	7,121	32	574	5,624	3,299	1,684
	1890	14,052	3,032	145,185	3,368	137,595	(2)	457	313	4,755	(2)	618	(2)	163	.....	1,597	.....
	1880	8,592	2,428	80,749	2,128	72,587	.....	.....	587	8,162	.....	.....	.....	.....	.....	.....	.....
	1870	11,871	(1)	55,062	(1)	48,418	.....	.....	(1)	6,644	.....	.....	.....	.....	.....	.....	.....
Montana	1900	1,080	311	46,981	460	29,374	19	85	51	9,965	78	1,988	17	4,310	1,196	63	5
	1890	289	94	2,848	72	2,105	(2)	17	23	666	(2)	43	.....	.....	.....	17	.....
	1880	196	63	1,498	31	544	.....	.....	39	954	.....	.....	.....	.....	.....	.....	.....
	1870	201	(1)	1,617	(1)	822	.....	.....	(1)	795	.....	.....	.....	.....	.....	.....	.....
Nebraska	1900	5,414	1,215	45,756	848	31,916	364	2,020	217	8,943	90	1,582	10	128	866	351	50
	1890	3,014	626	23,479	514	17,021	(2)	58	196	6,123	(2)	49	(2)	49	.....	179	.....
	1880	1,403	262	8,494	126	2,999	.....	.....	245	5,495	.....	.....	.....	.....	.....	.....	.....
	1870	670	(1)	3,311	(1)	1,865	.....	.....	(1)	1,446	.....	.....	.....	.....	.....	.....	.....
Nevada	1900	228	57	1,625	37	656	9	39	23	929	.....	.....	.....	.....	1	.....	.....
	1890	95	20	572	17	318	(2)	48	2	6	.....	.....	.....	.....	.....	.....	.....
	1880	184	26	716	23	608	.....	.....	6	108	.....	.....	.....	.....	.....	.....	.....
	1870	330	(1)	8,545	(1)	6,007	.....	.....	(1)	2,538	.....	.....	.....	.....	.....	.....	.....
New Hampshire	1900	4,671	1,687	211,221	1,091	91,541	57	670	1,418	112,755	65	1,467	16	362	2,004	2,422	927
	1890	3,229	1,351	116,830	729	46,888	(2)	3	1,437	68,842	(2)	42	(2)	100	.....	955	.....
	1880	3,181	1,653	87,750	456	18,595	.....	.....	2,122	69,155	.....	.....	.....	.....	.....	.....	.....
	1870	3,342	(1)	77,078	(1)	8,787	.....	.....	(1)	68,291	.....	.....	.....	.....	.....	.....	.....
New Jersey	1900	15,481	4,433	341,394	4,873	283,393	434	3,543	756	24,959	804	11,781	205	7,656	4,136	5,976	1,038
	1890	9,225	2,734	180,529	3,073	158,718	(2)	135	639	17,543	(2)	487	(2)	84	.....	3,562	.....
	1880	7,128	2,226	99,858	1,619	72,792	.....	.....	1,213	27,066	.....	.....	.....	.....	.....	.....	.....
	1870	6,636	(1)	58,139	(1)	32,307	.....	.....	(1)	25,832	.....	.....	.....	.....	.....	.....	.....
New Mexico	1900	420	111	4,360	94	3,579	11	64	28	559	.....	.....	1	150	8	.....	.....
	1890	127	56	1,825	46	1,492	.....	.....	18	323	.....	.....	.....	.....	.....	10	.....
	1880	144	78	1,359	19	427	.....	.....	69	932	.....	.....	.....	.....	.....	.....	.....
	1870	182	(1)	911	(1)	252	.....	.....	(1)	659	.....	.....	.....	.....	.....	.....	.....

[1] Not reported.

[2] Not reported separately.

TABLE XII.—AMOUNT OF EACH KIND OF POWER, BY STATES AND TERRITORIES: 1870 TO 1900, INCLUSIVE—Cont'd.

STATES AND TERRITORIES.	Year.	NUMBER OF ESTABLISHMENTS.		Total horsepower.	OWNED.								RENTED.		
					Engines.				Water wheels.		Electric motors.		Other power.		To this establishment.		By this establishment.
		Total.	Reporting power.		Steam.		Gas or gasoline.		Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Electric horsepower.	All other horsepower.	
					Number.	Horsepower.	Number.	Horsepower.									
New York	1900	78,658	19,656	1,181,369	13,980	677,219	1,971	16,810	5,839	368,456	2,324	29,860	390	6,080	48,148	34,796	9,805
	1890	65,840	13,395	776,820	10,372	513,560	(1)	1,990	6,439	231,959	(1)	2,447	(1)	1,141	.....	25,723	.....
	1880	42,739	11,776	454,143	6,672	234,795	.....	.....	9,752	219,348	.....	.....	.....	.....	.....	.....	.....
	1870	36,206	(2)	334,363	(2)	126,107	.....	.....	(2)	208,256	.....	.....	.....	.....	.....	.....	.....
North Carolina	1900	7,226	4,934	203,297	3,520	141,798	74	526	2,624	57,027	70	1,839	28	583	804	628	169
	1890	3,667	2,078	73,345	1,298	41,171	(1)	42	1,903	31,812	(1)	44	(1)	189	.....	87	.....
	1880	3,802	2,323	45,088	616	15,025	.....	.....	2,370	30,063	.....	.....	.....	.....	.....	.....	.....
	1870	3,642	(2)	33,152	(2)	6,941	.....	.....	(2)	26,211	.....	.....	.....	.....	.....	.....	.....
North Dakota	1900	1,130	304	8,392	150	6,680	139	903	20	581	6	44	4	30	127	27	12
	1890	382	98	3,589	87	2,985	(1)	12	16	540	(1)	2	(1)	23	.....	27	.....
	[3]1880	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	[3]1870	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Ohio	1900	32,398	9,716	850,600	10,911	758,743	1,224	14,593	867	24,219	1,722	33,419	106	2,977	8,783	7,866	5,394
	1890	28,678	7,216	418,783	7,703	382,301	(1)	1,183	1,134	27,342	(1)	1,705	(1)	372	.....	6,880	.....
	1880	20,699	6,684	261,143	6,215	222,502	.....	.....	2,080	38,641	.....	.....	.....	.....	.....	.....	.....
	1870	22,773	(2)	174,323	(2)	129,577	.....	.....	(2)	44,746	.....	.....	.....	.....	.....	.....	.....
Oklahoma	1900	870	229	9,385	206	9,020	35	207	2	21	3	12	1	10	.....	65	.....
	1890	72	11	161	11	161	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	[2]1880	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	[2]1870	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Oregon	1900	3,088	1,080	63,767	931	38,956	37	215	339	21,588	27	447	.....	.....	2,243	318	122
	1890	1,523	664	32,545	590	22,430	(1)	2	276	9,280	(1)	37	(1)	806	.....	490	.....
	1880	1,080	443	13,589	176	4,334	.....	.....	373	9,255	.....	.....	.....	.....	.....	.....	.....
	1870	969	(2)	8,277	(2)	2,471	.....	.....	(2)	5,806	.....	.....	.....	.....	.....	.....	.....
Pennsylvania	1900	52,185	17,336	1,859,265	20,955	1,611,815	1,687	27,449	4,067	86,223	4,548	85,434	343	9,985	22,454	15,905	6,133
	1890	39,339	12,091	986,789	13,751	894,007	(1)	919	4,671	82,462	(1)	2,162	(1)	312	.....	6,927	.....
	1880	31,232	10,381	512,408	7,913	402,132	.....	.....	7,075	110,276	.....	.....	.....	.....	.....	.....	.....
	1870	37,200	(2)	368,918	(2)	221,936	.....	.....	(2)	141,982	.....	.....	.....	.....	.....	.....	.....
Rhode Island	1900	4,189	1,390	156,550	1,175	115,876	48	427	364	29,085	152	1,926	67	2,595	2,969	3,722	474
	1890	3,377	926	112,949	852	83,477	(1)	18	344	27,197	(1)	295	(1)	51	.....	1,911	.....
	1880	2,205	608	63,575	476	41,335	.....	.....	386	22,240	.....	.....	.....	.....	.....	.....	.....
	1870	1,850	(2)	42,027	(2)	23,546	.....	.....	(2)	18,481	.....	.....	.....	.....	.....	.....	.....
South Carolina	1900	3,762	2,418	146,225	2,198	100,971	31	368	666	35,019	124	5,876	5	370	213	3,408	3
	1890	2,382	1,149	45,681	864	29,043	(1)	97	611	16,399	(1)	8	(1)	60	.....	74	.....
	1880	2,078	1,259	25,868	509	11,995	.....	.....	1,057	13,873	.....	.....	.....	.....	.....	.....	.....
	1870	1,584	(2)	14,932	(2)	4,587	.....	.....	(2)	10,395	.....	.....	.....	.....	.....	.....	.....
South Dakota	1900	1,639	510	12,611	316	9,443	171	1,349	50	1,466	7	134	18	99	108	12	.....
	1890	499	183	5,555	147	4,456	(1)	32	48	1,052	(1)	3	(1)	12	.....	.....	.....
	[3]1880	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	[3]1870	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Tennessee	1900	8,016	4,542	169,350	3,594	141,045	74	656	1,559	24,838	46	823	7	38	1,401	549	231
	1890	4,559	2,243	84,379	1,577	68,587	(1)	54	1,152	15,451	(1)	106	(1)	14	.....	217	.....
	1880	4,326	2,108	51,952	967	33,388	.....	.....	1,382	18,564	.....	.....	.....	.....	.....	.....	.....
	1870	5,317	(2)	37,981	(2)	18,467	.....	.....	(2)	19,514	.....	.....	.....	.....	.....	.....	.....
Texas	1900	12,289	5,265	240,133	5,393	231,345	213	1,165	111	3,782	61	916	28	253	2,400	272	520
	1890	5,268	1,983	68,580	2,066	65,391	(1)	157	121	2,633	(1)	166	(1)	59	.....	124	.....
	1880	2,996	1,334	30,534	1,167	28,026	.....	.....	174	2,508	.....	.....	.....	.....	.....	.....	.....
	1870	2,399	(2)	13,044	(2)	11,214	.....	.....	(2)	1,830	.....	.....	.....	.....	.....	.....	.....
Utah	1900	1,400	423	15,010	292	8,039	7	89	142	4,028	34	1,241	1	10	1,588	15	10
	1890	581	178	5,128	106	2,580	(1)	10	101	2,492	(1)	64	.....	.....	.....	32	.....
	1880	640	243	4,689	55	1,154	.....	.....	214	3,535	.....	.....	.....	.....	.....	.....	.....
	1870	588	(2)	2,500	(2)	331	.....	.....	(2)	2,169	.....	.....	.....	.....	.....	.....	.....
Vermont	1900	4,071	1,972	138,095	1,046	45,142	79	1,186	1,709	87,615	24	729	40	265	1,474	1,684	884
	1890	3,031	1,552	98,554	600	23,539	(1)	10	1,810	74,041	(1)	34	(1)	86	.....	844	.....
	1880	2,874	1,582	63,314	272	11,088	.....	.....	2,138	52,226	.....	.....	.....	.....	.....	.....	.....
	1870	3,270	(2)	51,322	(2)	6,425	.....	.....	(2)	44,897	.....	.....	.....	.....	.....	.....	.....
Virginia	1900	8,248	4,233	171,469	2,878	117,267	86	798	2,141	45,583	115	4,815	22	1,215	822	969	272
	1890	5,915	2,502	82,448	1,341	45,406	(1)	78	1,915	36,654	(1)	105	(1)	12	.....	193	.....
	1880	5,710	2,768	57,174	899	19,710	.....	.....	2,399	37,464	.....	.....	.....	.....	.....	.....	.....
	1870	5,933	(2)	49,612	(2)	8,410	.....	.....	(2)	41,202	.....	.....	.....	.....	.....	.....	.....
Washington	1900	3,631	1,219	88,802	1,450	78,066	31	189	165	7,148	36	575	8	72	2,570	182	18
	1890	1,548	578	42,642	644	37,659	(1)	3	111	4,851	(1)	63	(1)	50	.....	16	.....
	1880	261	70	4,395	61	3,210	.....	.....	46	1,185	.....	.....	.....	.....	.....	.....	.....
	1870	269	(2)	2,823	(2)	1,411	.....	.....	(2)	1,412	.....	.....	.....	.....	.....	.....	.....
West Virginia	1900	4,418	2,301	108,566	2,232	95,595	93	1,081	542	10,273	20	427	35	905	27	258	140
	1890	2,376	1,199	55,457	1,043	44,680	(1)	33	565	10,542	(1)	5	(1)	122	.....	75	.....
	1880	2,375	1,190	37,910	816	28,456	.....	.....	670	9,454	.....	.....	.....	.....	.....	.....	.....
	1870	2,444	(2)	27,331	(2)	17,136	.....	.....	(2)	10,195	.....	.....	.....	.....	.....	.....	.....
Wisconsin	1900	16,187	5,199	393,268	5,049	274,355	557	4,022	1,589	99,007	552	10,723	37	423	2,426	1,412	797
	1890	10,417	2,618	178,668	2,406	120,897	(1)	274	1,528	56,744	(1)	295	(1)	109	.....	549	.....
	1880	7,674	2,154	106,085	1,866	60,729	.....	.....	2,022	45,356	.....	.....	.....	.....	.....	.....	.....
	1870	7,013	(2)	64,223	(2)	30,509	.....	.....	(2)	33,714	.....	.....	.....	.....	.....	.....	.....
Wyoming	1900	334	97	4,335	85	3,486	14	42	19	667	8	80	2	58	7	.....	.....
	1890	190	41	1,829	52	1,608	.....	.....	9	216	(1)	5	.....	.....	.....	.....	.....
	1880	57	10	755	18	717	.....	.....	2	98	.....	.....	.....	.....	.....	.....	.....
	1870	32	(2)	344	(2)	310	.....	.....	(2)	34	.....	.....	.....	.....	.....	.....	.....

[1] Not reported separately

[2] Not reported.

[3] See Dakota.

TABLE XIII.—PER CENT THAT TOTAL HORSEPOWER OF EACH STATE AND TERRITORY IS OF THE TOTAL FOR THE UNITED STATES, AND THAT STEAM, WATER, AND OTHER POWER IS OF THE TOTAL FOR EACH STATE AND TERRITORY: 1870 TO 1900.

STATES AND TERRITORIES.	PER CENT OF TOTAL HORSEPOWER.				PER CENTS OF STEAM, WATER, AND OTHER POWER FOR EACH STATE AND TERRITORY.									
					1900			1890			1880		1870	
	1900	1890	1880	1870	Steam power	Water-power.	All other power.	Steam power.	Water-power.	All other power.	Steam power.	Water-power.	Steam power.	Water-power.
United States....	100.00	100.00	100.00	100.00	77.4	15.3	7.3	78.3	21.2	0.5	64.1	35.9	51.8	48.2
Alabama	1.99	1.72	0.81	0.80	88.5	9.4	2.1	89.7	10.2	0.1	57.2	42.8	41.3	58.7
Alaska	0.02	0.01			55.0	30.4	14.6	64.3	35.7					
Arizona	0.08	0.01	0.02	(1)	84.4	4.8	10.8	60.2	39.8		69.8	30.2	88.9	11.1
Arkansas	1.07	0.64	0.46	0.33	96.5	2.5	1.0	95.3	4.6	0.1	87.1	12.9	79.8	20.2
California	1.19	1.23	0.97	1.08	78.8	3.8	17.4	92.0	7.0	1.0	85.3	14.7	72.9	27.1
Colorado	0.40	0.55	0.17	0.09	89.3	3.5	7.2	94.4	5.3	0.3	68.1	31.9	64.4	35.6
Connecticut	2.39	2.74	3.47	3.43	66.1	26.4	7.5	60.1	39.6	0.3	48.2	51.2	32.3	67.7
Dakota	(2)	(2)	0.07	0.01	(2)	(2)	(2)	(2)	(2)	(2)	63.9	36.1	76.5	23.5
Delaware	0.35	0.45	0.45	0.36	77.8	14.8	7.4	81.7	17.6	0.7	69.0	31.0	50.5	49.5
Dist. of Columbia	0.09	0.19	0.09	0.08	82.1	3.5	14.4	91.5	7.1	1.4	72.0	28.0	41.8	58.2
Florida	0.36	0.27	0.21	0.16	93.9	2.7	3.4	96.5	3.1	0.4	86.9	13.1	85.7	14.3
Georgia	1.68	1.41	1.50	1.63	76.4	21.5	2.1	65.9	33.7	0.4	41.2	58.8	28.3	71.7
Idaho	0.06	0.03	0.05	0.03	69.3	29.9	0.8	48.6	51.2	0.2	32.5	67.5	51.3	48.7
Illinois	5.45	4.81	4.23	3.67	85.2	2.1	12.7	93.7	5.6	0.7	87.9	12.1	84.9	15.1
Indiana	3.12	3.21	3.86	4.28	89.2	4.4	6.4	91.2	8.5	0.3	83.5	16.5	76.6	23.4
Indian Territory	0.11	0.01			97.2	2.4	0.4	82.3	17.7					
Iowa	1.11	1.31	1.59	1.69	80.1	9.7	10.2	83.4	16.2	0.4	62.4	37.6	64.0	36.0
Kansas	0.66	0.72	0.62	0.35	77.6	11.9	10.5	81.0	18.0	1.0	63.9	36.1	78.1	21.9
Kentucky	1.46	1.39	1.60	1.69	91.0	5.6	3.4	91.9	7.6	0.5	83.6	16.4	80.7	19.3
Louisiana	1.92	0.51	0.33	1.07	98.3	0.2	1.5	97.6	0.2	2.2	99.2	0.8	99.4	0.6
Maine	2.40	2.53	2.95	3.39	33.4	61.6	5.0	29.1	70.8	0.1	20.7	79.3	11.9	88.1
Maryland	1.26	1.23	1.50	1.38	93.5	9.7	6.8	78.2	21.3	0.5	64.8	35.2	43.1	56.9
Massachusetts	7.29	8.70	9.08	7.86	70.3	22.8	6.9	68.6	30.8	0.6	55.3	44.7	42.6	57.4
Michigan	3.51	4.31	4.83	4.51	83.7	10.8	5.5	84.4	15.3	0.3	79.1	20.9	67.0	33.0
Minnesota	1.69	1.89	1.58	0.86	79.7	14.1	6.2	75.3	24.3	0.4	46.7	53.3	35.2	64.8
Mississippi	1.10	0.59	0.54	0.53	96.4	2.8	0.8	92.1	7.8	0.1	81.3	18.7	80.3	19.7
Missouri	1.93	2.44	2.37	2.35	87.7	3.1	9.2	95.9	3.3	0.8	89.9	10.1	87.9	12.1
Montana	0.42	0.05	0.04	0.07	62.5	21.2	16.3	74.5	23.4	2.1	36.3	63.7	50.8	49.2
Nebraska	0.41	0.39	0.25	0.14	69.7	19.6	10.7	73.2	26.1	0.7	35.3	64.7	56.3	43.7
Nevada	0.02	0.01	0.02	0.36	40.4	57.2	2.4	85.5	1.6	12.9	84.9	15.1	70.3	29.7
New Hampshire	1.87	1.96	2.57	3.28	43.3	53.4	3.3	40.8	59.1	0.1	21.2	78.8	11.4	88.6
New Jersey	3.02	3.03	2.93	2.48	88.0	7.3	4.7	89.8	9.8	0.4	72.9	27.1	55.6	44.4
New Mexico	0.04	0.03	0.04	0.04	82.1	12.3	5.1	82.3	17.7		31.4	68.6	27.7	72.3
New York	10.46	13.05	13.31	14.25	57.3	31.2	11.5	69.2	30.1	0.7	51.7	48.3	37.7	62.3
North Carolina	1.80	1.23	1.32	1.41	69.7	28.1	2.2	36.2	43.4	0.4	33.3	66.7	20.9	79.1
North Dakota	0.07	0.06	(3)	(3)	79.6	6.9	13.5	83.9	15.1	1.0	(3)	(3)	(3)	(3)
Ohio	7.53	7.03	7.66	7.43	89.2	2.9	7.9	92.6	6.6	0.8	85.2	14.8	74.3	25.7
Oklahoma	0.08	(1)			96.6	0.2	3.2	100.0						
Oregon	0.56	0.55	0.40	0.35	61.1	33.9	5.0	69.8	29.1	1.1	31.9	68.1	29.9	70.1
Pennsylvania	16.45	16.57	15.02	15.51	86.7	4.6	8.7	91.3	8.3	0.4	78.5	21.5	61.0	39.0
Rhode Island	1.39	1.90	1.86	1.79	74.0	18.6	7.4	75.6	24.1	0.3	65.0	35.0	56.0	44.0
South Carolina	1.29	0.77	0.76	0.64	69.1	23.9	7.0	63.7	35.9	0.4	46.4	53.6	30.4	69.6
South Dakota	0.11	0.09	(3)	(3)	74.9	11.6	13.5	80.2	18.9	0.9	(3)	(3)	(3)	(3)
Tennessee	1.50	1.42	1.52	1.62	83.3	14.7	2.0	81.6	18.3	0.2	64.3	35.7	48.6	51.4
Texas	2.13	1.15	0.90	0.56	96.3	1.6	2.1	95.6	3.8	0.6	91.8	8.2	86.0	14.0
Utah	0.13	0.09	0.14	0.11	53.6	26.8	19.6	50.0	48.6	1.4	24.6	75.4	13.2	86.8
Vermont	1.22	1.66	1.86	2.19	32.7	63.4	3.9	24.4	75.5	0.1	17.5	82.5	12.5	87.5
Virginia	1.52	1.38	1.68	2.11	68.4	26.6	5.0	55.3	44.5	0.2	34.5	65.5	16.9	83.1
Washington	0.78	0.72	0.13	0.12	87.9	8.1	4.0	85.3	11.4	0.3	73.0	27.0	50.0	50.0
West Virginia	0.96	0.93	1.11	1.16	86.6	9.5	2.5	80.7	19.0	0.3	75.1	24.9	62.7	37.3
Wisconsin	3.48	3.00	3.11	2.74	69.8	25.2	5.0	67.8	31.8	0.4	57.3	42.7	47.5	52.5
Wyoming	0.04	0.03	0.02	0.01	80.4	15.4	4.2	87.9	11.8	0.3	95.0	5.0	90.1	9.9

[1] Less than one-hundredth of 1 per cent. [2] See North Dakota and South Dakota. [3] See Dakota.