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Growth and Diffusion of Power in Manufacturing, 1838–1919

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Primary-Power Capacity

The data on the growth, diffusion, and changing composition of primary-power capacity in manufacturing presented in this paper are part of a larger and more detailed study in progress. Primary power means the work done by "prime movers," which convert the energy of nature directly into the energy of motion. The study covers prime movers developed or improved in the nineteenth century, the water wheel, the steam engine, the steam turbine, the internal combustion engine, and the electric motor. The list of the prime movers utilizing inanimate sources of energy excludes only the windmill, for which no adequate sources of information have been located. Electric motors are not prime movers from the standpoint of the economy, since they consume electric energy which must first be produced by one of the other prime movers, rather than converting the energy of nature directly into the energy of motion. From the standpoint of the firm, however, when electricity is created by a utility and purchased by the firm to operate an electric motor, the motor is a prime mover.

The basis used for measuring each type of primary power is the capacity of the motor or engine. Capacity refers to the rated ability of a machine to perform tasks requiring motive power; in other words, it is the potential work output of the machine. Changes in the efficiency with which the prime mover is used or in the portion of capacity used represent an important aspect of the growth, diffusion, and changing composition of power. Nevertheless, for some purposes, capacity provides an adequate representation of the role of the various types of primary power in manufacturing. The standard unit for measuring power capacity is horsepower, one unit of which is equivalent to a rate of 550 foot-pounds per second or 33,000 foot-pounds per minute.

NOTE: I am grateful to Richard A. Easterlin of the University of Pennsylvania for his advice during the preparation of this paper.

The period 1838 to 1919 was one in which primary-power capacity in manufacturing expanded substantially in the aggregate. The two basic tables (Tables A-1 and A-2) on power capacity, by geographic division and industry group, show that all primary-power capacity expanded from 2,346,000 horsepower in 1869 to 29,410,000 horsepower in 1919. Breaking down this total by type of power, one finds that steam-power capacity grew from 36,100 hp in 1838 to 1,216,000 hp in 1869 to 13,840,000 hp in 1919; and water-power capacity grew from 1,130,000 to 1,765,000 hp between 1869 and 1919. In addition, purchased electric power, first recorded as a separate source of power in the Census in 1899, contributed 9,348,000 hp to total primary-power capacity in 1919. Finally, there were internal combustion engines, first recorded in 1889, and steam turbines, first recorded separately in 1919, which had a capacity of 1,259,000 and 3,198,000 hp, respectively, in 1919. During the period of that absolute growth in capacity, there were, within each geographic division and industry group, changes in the proportion of total capacity assignable to the different types of power. Furthermore, the shares of various geographic divisions and industry groups in the total of each type of power changed. In the following paragraphs some of these developments are summarized.

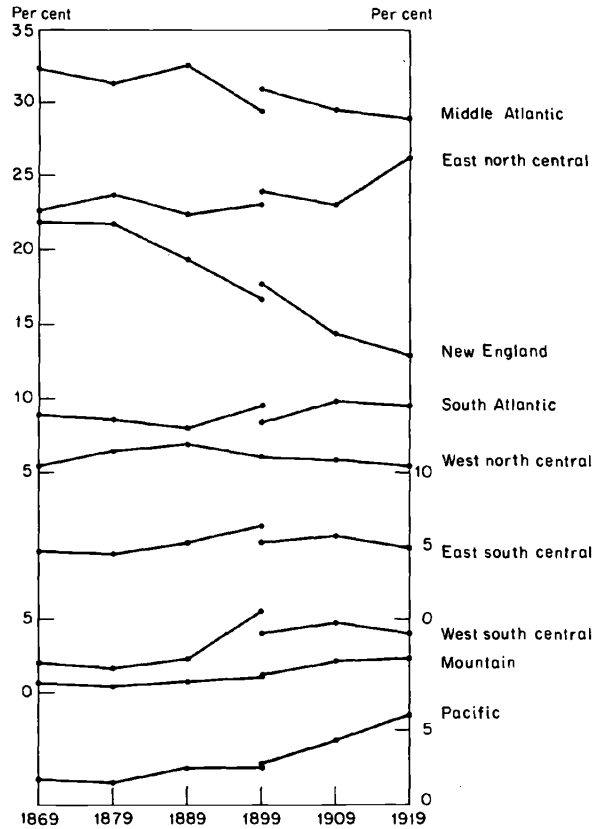
The changing relative importance of each type of power in the total is presented in Table B-1, in terms of the varying rates of growth of each power source, and in Table B-2, in terms of the percentage distribution of total primary power by type. Although exact figures are not available on the relative importance of water power in the period before the Civil War, it seems reasonable to infer that water was the major source of power in manufacturing well past the middle of the century. This conclusion is based on the fact that, after its most rapid period of growth, 1838–69, steam was only slightly more important than water as a source of power. From 1869 to 1899, the relative position of steam continued to improve at the expense of water, reaching its peak of importance at the latter date, when it accounted for over four-fifths of total primary-power capacity. Then it too began to lose ground as electric power began to come into use. By 1919, electricity was challenging the dominant position of steam.

Regional Distribution

The share of the northern geographic divisions in total primary power declined from 1869 to 1919 but, as of the latter date, there was still a substantial concentration of total power capacity in these divisions, i.e., 73.4 per cent of the total (Table B-3 and Chart 1). The decline in importance of the North in the share of total primary power is attributable

CHART 1

Percentage Distribution of Total Primary-Power Capacity in Manufacturing, by Geographic Division, 1869–1919



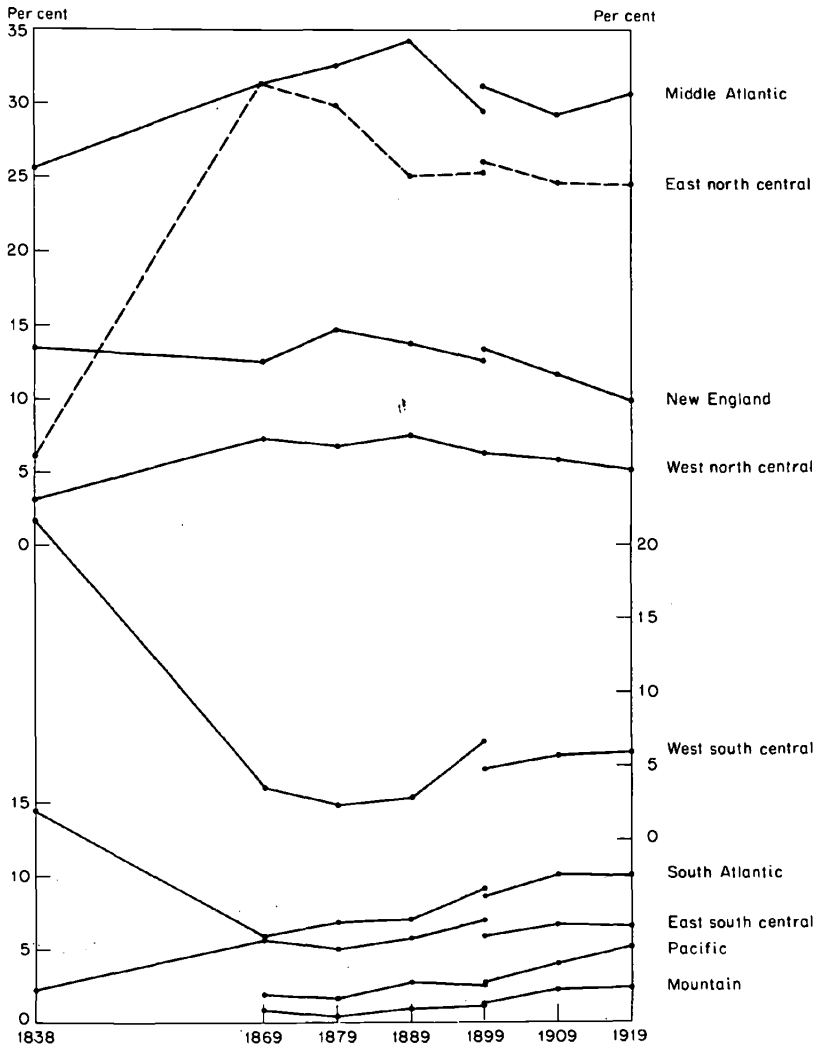
Source: Table B-3.

mainly to the declining importance of the New England division. The Middle Atlantic and east north central divisions together accounted for over 50 per cent of the total capacity throughout the period. Each of the southern and western divisions increased its share between 1869 and 1919, with the Pacific division having by far the largest increase.

A similar pattern appears in the relations between the individual types of power. For water power, the share of the four northern divisions in the total was over 80 per cent in 1869 and had increased slightly by 1919

CHART 2

Percentage Distribution of Total Steam-Power Capacity in Manufacturing, by Geographic Division, 1838–1919



Source: Table B-5.

(Table B-4). The increase was attributable mainly to the New England states which, as will be pointed out again below, were much slower than the other states to reduce their dependence on water power. The Middle Atlantic states suffered a decline in their share, which corresponded to the increase in the share of New England. Given these shifts in their relative importance, the New England and Middle Atlantic divisions combined accounted for over 60 per cent of the total water-power capacity at each Census date. Over this same period, the share of the southern divisions declined slightly, while the western divisions increased their share.

As for steam power, in 1838, the North and the South shared in the total capacity, the northern share being somewhat larger (Table B-5 and Chart 2). Between 1838 and 1869, the major change was a drop in the share of the west south central division and an increase in the share of the east north central division. As a result, by 1869 the North, particularly the Middle Atlantic and east north central divisions, dominated total steam-power capacity, accounting for over 80 per cent of the total. Although subsequently the North's share declined, owing mainly to the drop in capacity in the New England and east north central divisions with a corresponding increase in each of the southern and western divisions, it was still 70 per cent of the total in 1919. By states, the concentration of steam-power capacity is even more evident (Table B-6). The top five states at each of the selected dates had about one-half the total capacity.

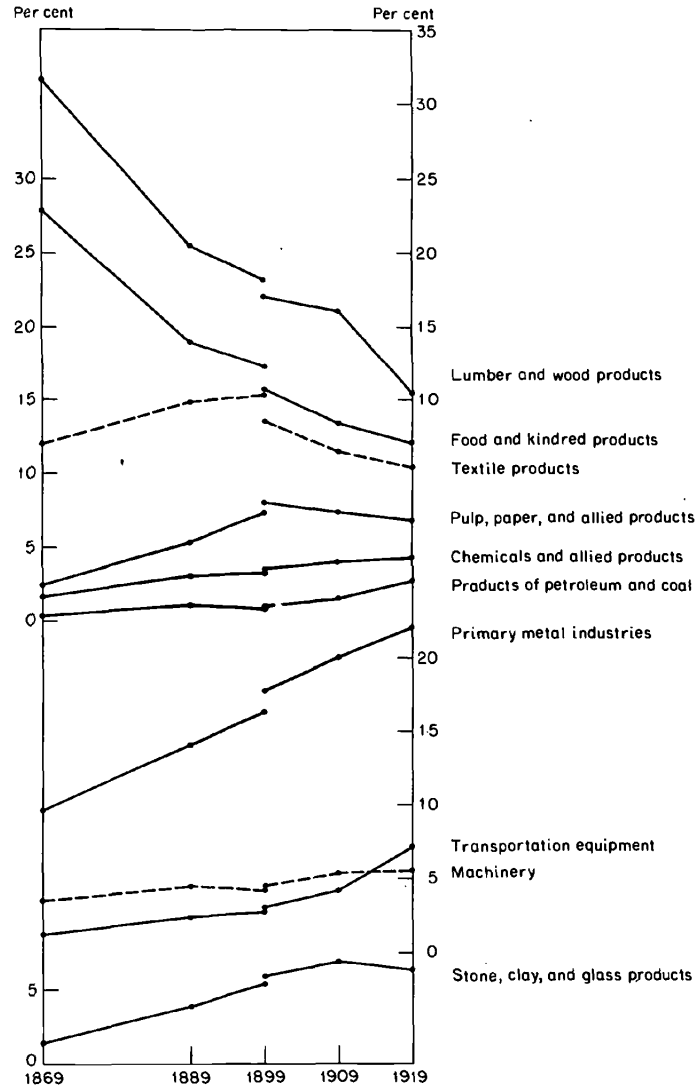
The distribution of purchased electric power, which was first recorded separately in the Census of 1899, also shows the relative significance of the North, and particularly the Middle Atlantic and east north central divisions (Table B-7). Although the share of the two divisions combined remained fairly constant, there was a shift in relative importance from the Middle Atlantic to the east north central division over the twenty-year period. The western divisions, especially the Pacific states, increased their share. The West had over 10 per cent of total electric capacity at each Census date, giving further evidence of its increased importance as a user of power.

Industrial Distribution

The distribution of total primary-power capacity, by industry group, shows more significant movements than the distribution by geographic division does. The movements were away from concentration of capacity in a few industry groups and also a greater shift in importance of the various groups, while two geographic divisions were initially, and remained throughout the period, the areas of greatest capacity. The shares of each industry group in total primary-power capacity (Table B-8) reveal that

CHART 3

Percentage Distribution of Total Primary-Power Capacity in Manufacturing, by Selected Industry Group, 1869–1919



Source: Table B-8.

in 1869 the lumber and food groups together had almost 60 per cent of total capacity. By 1919, the share of these two groups was only 22 per cent, while the primary metals group, continuously increasing its share between 1869 and 1919, became the group with the largest capacity. It is also notable that the four leading industry groups in 1919 did not have as large a share of capacity as the lumber and food groups had in 1869. Chart 3 shows the changing shares of total primary-power capacity of certain selected industry groups and points out the substantial shifting which was taking place. The groups presented in the chart are those that showed more than a 2 per cent change between their high and low points during the fifty-year period.

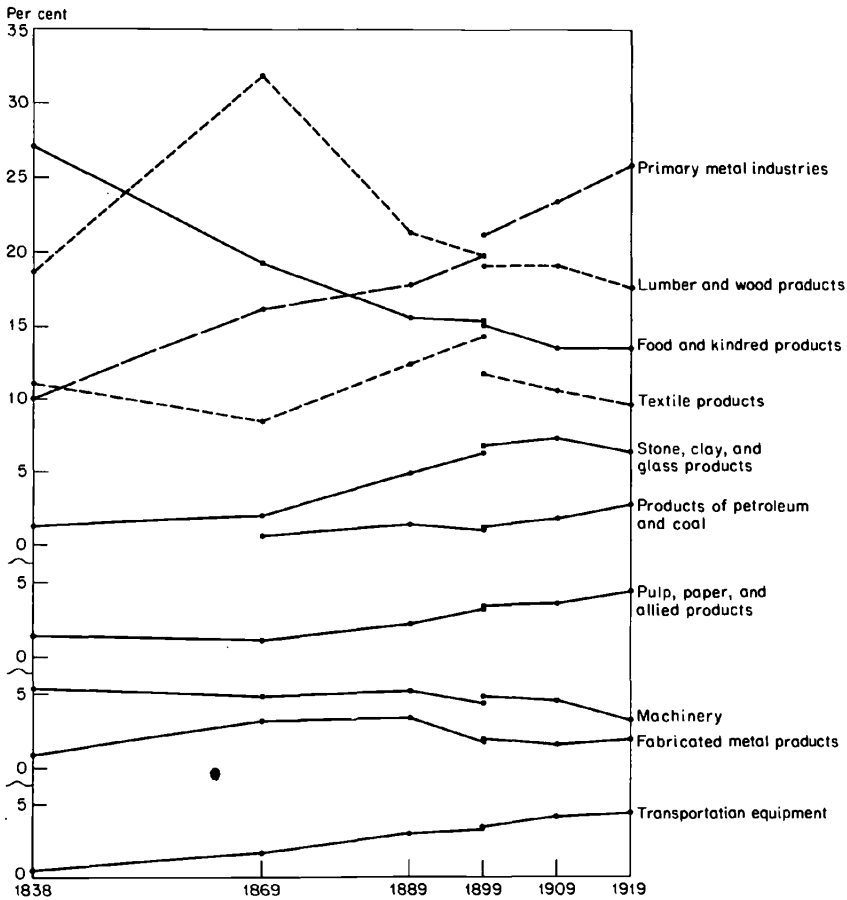
The distribution of total water-power capacity became more concentrated between 1869 and 1919, but there was a radical shift in the industry groups with the largest shares (Table B-9). In 1869 the food and lumber groups were dominant, while in 1919 the pulp and paper group, which had only 4 per cent of total capacity in 1869, had over 50 per cent of the total. The pulp and paper group continued to have a large portion of its total power capacity in the form of water power long after the other groups had come to depend on steam and eventually on electricity. As a result, the pulp and paper group gained an increasing share of total water power.

The shares of the top four industry groups (food, textiles, lumber, and primary metals) in total steam-power capacity remained about the same between 1838 and 1919, although between 1868 and 1919 their shares declined slightly (Table B-10). In addition, during 1838–1919 there were substantial changes in the share of capacity within the top four groups. Chart 4 shows the movements in those four groups, as well as in other industry groups, where the share changed by more than 2 percentage points between the high and low points. The most significant movements were the continuous decline in the share of the food group, the continuous increase in the share of primary metals, and the increase in the lumber group's share between 1838 and 1869, followed by a continuous decline.

The shares of purchased electricity were much more dispersed among the various industry groups than shares of the other types of power were (Table B-11). Two industry groups among the leaders in the share of total electric capacity—machinery and transportation equipment—had only a small share of total steam and water capacity. Two other facts brought out in Table B-11 (also emphasized in the discussion of the shares of each industry group in total primary power, water power, and steam power) are, first, the growing insignificance of the lumber group which, up

CHART 4

Percentage Distribution of Total Steam-Power Capacity in Manufacturing, by Selected Industry Group, 1838–1919



Source: Table B-10.

until 1899, had the largest share of total primary-power capacity[1] and, second, the increasing importance of the primary metals group.

Use of a two-digit industry classification tends to obscure the importance of certain Census industries within the major industry groups, as well as the changes taking place in the relative importance of these industries. There is, for example, the dominance of sawed lumber within the lumber and wood products group and of iron and steel in the primary metals group. There is also the declining relative importance of flour and gristmill products within the food group. To trace particular Census industries through the period is not always possible, because of the changes in definition and classification by the Bureau of the Census. Nevertheless, this aspect of the analysis is significant and will be developed more fully in the larger study.

Distribution by Type of Power

Tables B-12 and B-13 show the percentage distribution of primary-power capacity, by type of power, in each geographic division and industry group. The general pattern described earlier applies for the most part to each of them. Chart 5, for example, shows the percentage of steam- to primary-power capacity in each industry group, during the period 1869 to 1919. The similarities in the general pattern in the various groups is striking. Exceptions to the pattern in steam as well as in water and electricity are discussed below.

The timing of the peak for the relative importance of steam power varies. In certain divisions and industry groups, the peak is in 1889 or 1909 rather than 1899. In addition, the importance of steam, as well as of water and electricity, within each of the divisions and industry groups differs somewhat. The more notable differences by geographic divisions are, first, the continuing importance of water power in the New England states after the other divisions had reduced their share of water to relative insignificance. Next is the very early adoption and exceptionally large relative importance of steam power in the west south central states up to 1919. Finally, there is the importance of electricity in the Pacific states, which was the only group of states to use more purchased electricity than steam as early as 1919.

On an industry basis, in 1869, in only three groups—food, textiles, and pulp and paper—did water account for more than 50 per cent of total power capacity. Of these, only the pulp and paper group continued to depend on water for a substantial portion of its power needs. In fact,

[1] Only part of this decline can be attributed to the change in coverage by the Bureau of the Census after 1899 (see Appendix A).

CHART 5

Share of Steam in Primary-Power Capacity in All Manufacturing and in Each Industry Group, 1869–1919

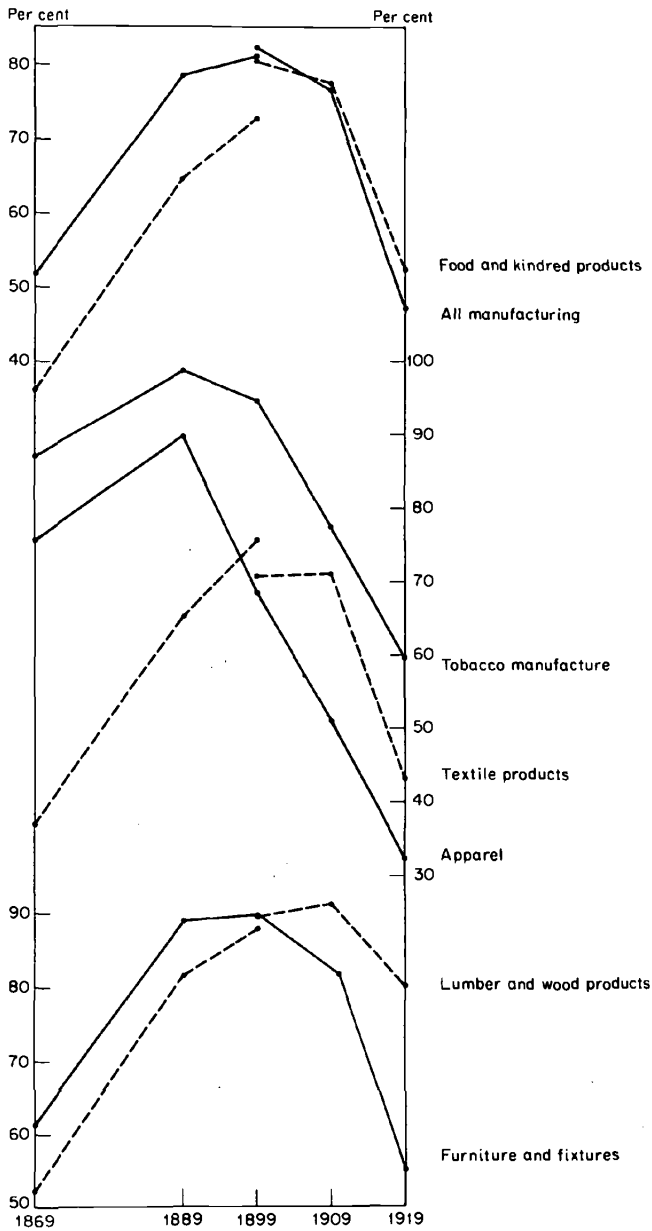


CHART 5 (continued)

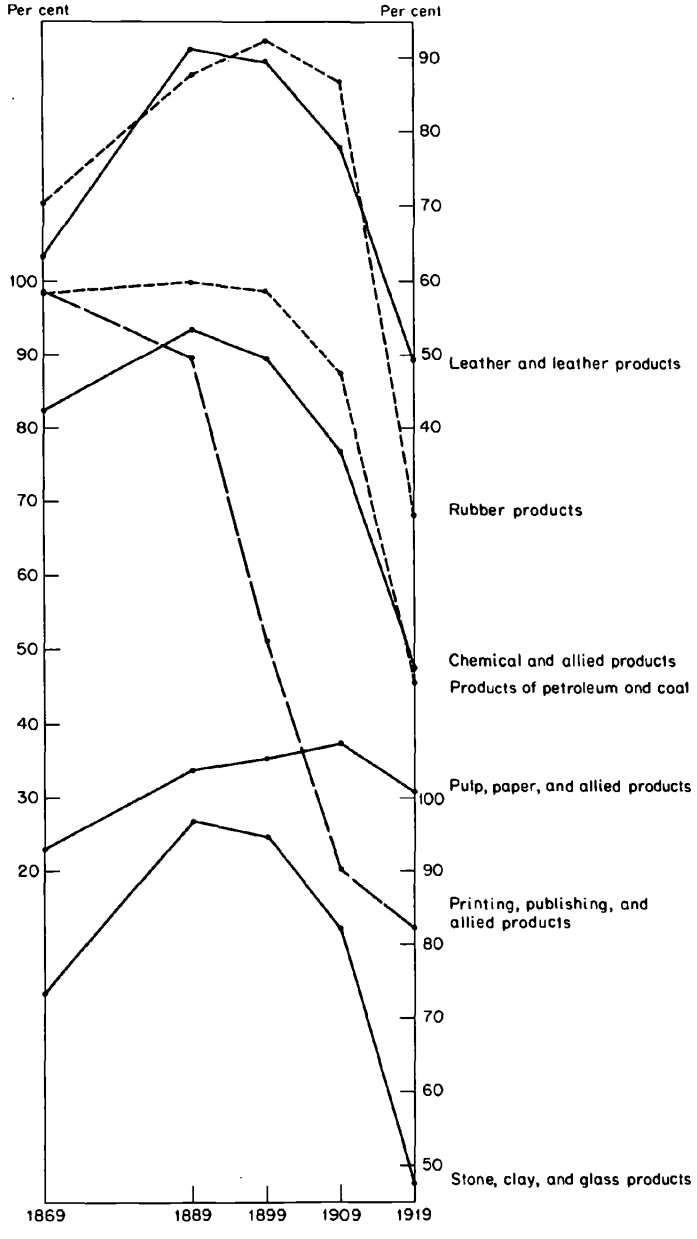
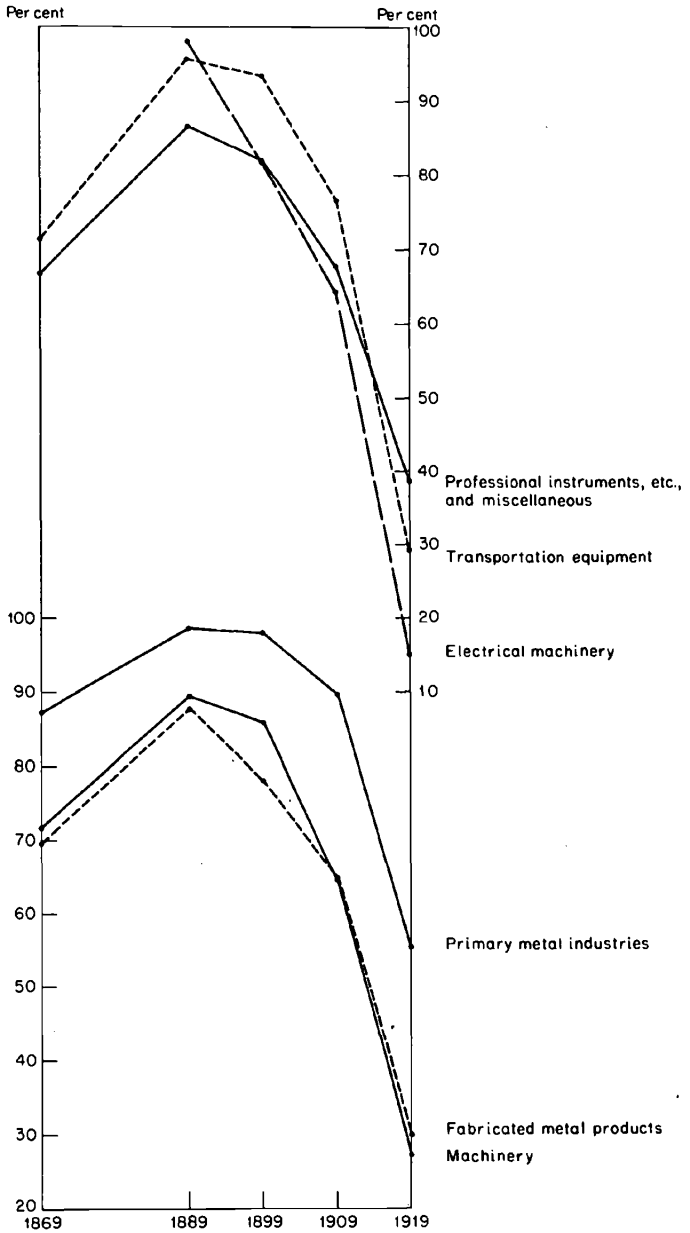


CHART 5 (concluded)



Source: Table B-13.

as late as 1919, pulp and paper still had 46 per cent of its total power capacity in the form of water. At the other extreme were the printing and publishing and primary metals groups, which were almost totally dependent on steam as early as 1869. The primary metals group continued that dependence up to 1909. The printing and publishing group, however, was the first to become dependent on purchased electricity as a source of power. As early as 1899, 30 per cent of its total capacity was purchased electricity, and by 1919 the figure was 82.6 per cent. A number of other industry groups adopted purchased electricity almost immediately, e.g., apparel and electric machinery; and by 1919 they had increased the relative share of purchased electricity within their groups to over 50 per cent. At the other extreme was the lumber group which, in 1919, still used steam for 80 per cent of its primary power, and electricity for only 10 per cent.

Appendix A: Notes on Scope, Sources, and Methods

COVERAGE OF POWER

The figures used for total primary power are based on the sum of steam, water, gas, and purchased electric power. In certain Census years, there are also classifications of "other owned" and "other rented" power. Since the amounts involved are relatively insignificant and not assignable to any particular type of power, they were excluded from the total. To get the actual amount of total primary power capacity at each Census date, the following amounts of horsepower should be added to the figures given in Tables A-1 and A-2.

	Other Horsepower, Rented (thous.)	*Other Horsepower, Owned (thous.)*
1889	89	5
1899A	137	54
1899B	137	20
1909	124	29
1919	95	–

Horsepower capacity in Alaska was included in the Censuses in 1889 and 1899.

	Horsepower Capacity in Alaska		
	1889	*1899A*	*1899B*
Steam	290	1078	954
Water	161	597	117

These amounts were excluded from Tables A-1 and A-2 in order to make them consistent with the other Census dates.

TABLE A-1

PRIMARY-POWER CAPACITY IN MANUFACTURING, BY GEOGRAPHIC DIVISION
(thousand horsepower)

	1838	1869			1879			1889				1899A				
	Steam	Water	Steam	Total	Water	Steam	Total	Water	Steam	Gas	Total	Water	Steam	Gas	Electric (purch.)	Total
United States	36.1	1,130	1,216	2,346	1,225	2,185	3,411	1,255	4,581	9.0	5,845	1,727	8,741	144	184	10,796
New England	4.9	362	153	515	423	320	743	497	634	0.5	1,131	656	1,101	11	32	1,799
Middle Atlantic	9.2	376	380	756	357	710	1,066	332	1,566	3.0	1,901	480	2,572	48	75	3,175
East north central	2.2	150	381	531	158	650	808	155	1,152	3.0	1,310	195	2,205	48	31	2,479
West north central	1.1	37	89	127	71	150	221	60	345	0.8	406	66	550	20	15	651
South Atlantic	5.2	140	70	210	146	149	294	145	319	0.8	466	210	799	7	5	1,022
East south central	0.8	41	68	109	43	110	153	35	268	0.3	303	59	610	3	4	676
West south central	7.8	4	42	46	5	53	58	5	132	0.4	137	7	583	2	4	596
Mountain	0	7	10	17	9	8	17	7	40	0.1	47	20	98	1	4	123
Pacific	0	14	22	36	15	36	51	19	125	0.4	145	34	223	4	15	275
Not assignable	4.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

(continued)

TABLE A-1 (concluded)

	1899B					1909					1919					
	Water	Steam	Gas	Electric (purch.)	Total	Water	Steam	Gas	Electric (purch.)	Total	Water	Steam	Gas	Electric (purch.)	Steam Turbines	Total
United States	1,454	8,140	135	183	9,911	1,823	14,199	751	1,749	18,522	1,765	13,840	1,259	9,348	3,198	29,410
New England	619	1,093	10	32	1,754	757	1,657	42	219	2,675	748	1,356	34	1,130	511	3,780
Middle Atlantic	410	2,529	46	74	3,059	470	4,152	274	569	5,465	396	4,231	410	2,455	1,019	8,513
East north central	171	2,118	45	31	2,365	208	3,491	283	376	4,359	253	3,389	428	2,659	973	7,703
West north central	52	513	18	15	597	86	839	57	115	1,098	93	707	102	596	95	1,593
South Atlantic	125	700	7	5	837	183	1,431	36	171	1,822	173	1,387	137	887	208	2,791
East south central	25	480	2	4	511	29	954	12	39	1,034	25	912	23	311	143	1,414
West south central	3	388	2	4	396	3	806	29	32	870	3	813	81	219	64	1,180
Mountain	18	98	1	4	121	22	307	4	67	399	16	322	10	260	78	685
Pacific	31	221	4	14	270	63	563	12	162	801	59	722	33	830	108	1,752
Not assignable	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note: For sources and methods, see Appendix A and source to Table A-2. Calculations were made with unrounded figures. Detail does not necessarily add to totals because of rounding.

TABLE A-2

PRIMARY-POWER CAPACITY IN MANUFACTURING, BY INDUSTRY GROUP
(thousand horsepower)

Major Group Number	Industry Group	1838	1869			1889			
		Steam	Water	Steam	Total	Water	Steam	Gas	Total
	All Manufacturing	36.1	1,130	1,216	2,346	1,255	4,581	9.0	5,845
20	Food and kindred products	9.8	417	235	652	392	716	1.0	1,109
21	Tobacco manufacture	—	0.4	3	3	0.1	14	0.1	14
22	Textile mill products	4.0	177	104	281	303	568	0.2	871
23	Apparel	0.4	3	11	14	2	26	0.7	29
24	Lumber and wood products	6.7	355	387	742	222	975	0.2	1,198
25	Furniture and fixtures	—	12	18	30	9	76	0.2	85
26	Pulp, paper, and allied products	0.5	44	13	57	205	105	0.2	311
27	Printing, publishing, and allied products	—	0.1	9	9	3	49	3.0	54
28	Chemicals and allied products	0.5	7	31	38	12	172	0.3	184
29	Products of petroleum and coal	0	0.1	7	7	0.1	66	0.1	66
30	Rubber products	—	2	4	6	3	24	—	27
31	Leather and leather products	0.4	16	28	44	7	84	0.6	92
32	Stone, clay, and glass products	0.5	9	25	34	7	223	0.1	230
33	Primary metal industries	3.6	29	197	226	12	814	0.1	826
34	Fabricated metal products	0.3	17	38	55	21	151	0.5	172
35	Machinery	1.9	23	59	82	27	234	0.4	261
36	Electric machinery	0	--	0	--	12	62	--	74
37	Transportation equipment	0.1	8	21	29	6	136	0.2	142
38	Professional instruments, etc., and miscellaneous	0.6	5	10	15	6	44	0.5	50
	Nonmanufacturing	1.7	7	17	23	6	44	0.4	50
	Not assignable	4.9	0	0	0	0	0	0	0
	Adjustments to agree with Table A-1	0	0	0	0	0	0	0	0

(continued)

TABLE A-2 (continued)

Major Group Number	Industry Group	1899A Water	1899A Steam	1899A Gas	1899A Electric (purch.)	1899A Total	1899B Water	1899B Steam	1899B Gas	1899B Electric (purch.)	1899B Total
	All Manufacturing	1,727	8,741	144	184	10,796	1,454	8,140	135	183	9,911
20	Food and kindred products	462	1,358	31	19	1,871	254	1,232	31	19	1,536
21	Tobacco manufacture	0.4	23	0.4	0.5	24	0.4	23	0.4	0.5	24
22	Textile mill products	388	1,252	3	10	1,653	378	949	3	10	1,339
23	Apparel	4	47	6	13	69	4	47	6	13	69
24	Lumber and wood products	222	1,727	11	4	1,963	168	1,551	11	4	1,734
25	Furniture and fixtures	8	119	3	3	132	8	119	3	3	132
26	Pulp, paper, and allied products	507	279	2	2	790	507	279	2	2	790
27	Printing, publishing, and allied products	3	56	15	35	108	3	56	15	35	108
28	Chemicals and allied products	12	313	3	21	350	12	313	3	21	350
29	Products of petroleum and coal	—	94	1	0.1	95	—	94	1	0.1	95
30	Rubber products	5	65	—	0.2	70	5	65	—	2	70
31	Leather and leather products	6	132	3	7	147	6	132	3	7	147
32	Stone, clay, and glass products	18	554	7	5	584	18	554	7	5	584
33	Primary metal industries	27	1,727	5	4	1,762	27	1,727	5	4	1,762
34	Fabricated metal products	19	155	8	16	199	19	155	8	16	199
35	Machinery	28	387	20	16	451	28	387	20	16	451
36	Electric machinery	1	35	2	5	43	1	35	2	5	43
37	Transportation equipment	7	276	6	6	295	7	276	6	6	295
38	Professional instruments, etc., and miscellaneous	6	72	4	6	88	6	72	4	6	88
	Nonmanufacturing	4	71	13	7	95	4	71	13	7	95
	Not assignable	0	0	0	0	0	0	0	0	0	0
	Adjustments to agree with Table A-1	0	0	0	4	4	0	4	-9	3	-2

(continued)

TABLE A-2 (concluded)

Major Group Number	Industry Group	1909					1919					
		Water	Steam	Gas	Electric (purch.)	Total	Water	Steam	Gas	Electric (purch.)	Steam Turbines	Total
	All Manufacturing	1,823	14,199	751	1,749	18,522	1,765	13,840	1,259	9,348	3,198	29,410
20	Food and kindred products	275	1,921	102	183	2,480	197	1,875	187	1,141	168	3,567
21	Tobacco manufacture	0.2	22	0.8	5	28	0.4	26	0.3	14	2	43
22	Textile mill products	443	1,509	12	160	2,124	448	1,322	12	841	446	3,068
23	Apparel	5	73	10	55	143	4	67	4	129	2	206
24	Lumber and wood products	151	2,709	44	71	2,975	74	2,441	51	314	172	3,052
25	Furniture and fixtures	8	211	9	31	259	5	176	7	115	16	320
26	Pulp, paper, and allied products	794	515	10	57	1,375	916	613	6	305	151	1,990
27	Printing, publishing, and allied products	2	60	33	203	298	1	46	17	311	1	376
28	Chemicals and allied products	18	562	14	137	732	10	599	34	454	168	1,264
29	Products of petroleum and coal	4	249	14	18	285	0.3	368	53	198	188	808
30	Rubber products	5	108	2	9	124	6	120	4	193	106	429
31	Leather and leather products	6	207	12	40	265	5	187	8	143	37	380
32	Stone, clay, and glass products	24	1,042	77	127	1,270	23	884	127	701	123	1,859
33	Primary metal industries	27	3,319	219	135	3,700	22	3,575	554	1,236	1,079	6,465
34	Fabricated metal products	19	217	33	66	335	15	265	38	528	44	890
35	Machinery	28	637	103	217	983	25	438	81	954	120	1,618
36	Electric machinery	1	106	7	51	164	2	72	8	253	144	478
37	Transportation equipment	6	589	34	140	769	3	613	39	1,232	206	2,093
38	Professional instruments, etc., and miscellaneous	8	140	15	43	206	7	141	12	183	22	365
	Nonmanufacturing	0.6	4	0.1	0.7	6	2	13	19	103	2	138
	Not assignable	0	0	0	0	0	0	0	0	0	0	0
	Adjustments to agree with Table A-1	0	0	0	0	0	0	0	0	0	0	0

Note: For sources and methods, see Appendix A. Calculations were made with unrounded figures. Detail does not necessarily add to totals because of rounding. A distinction is made between a rounded-off zero, shown as --, and a real zero, shown as 0.

SOURCE, BY CENSUS YEAR
TABLES A-1 AND A-2

1838: House of Representatives, 25th Cong., 3d sess., *Steam Engines*, H. Ex. Doc. 21, Washington, 1839, pp. 18-367, 379.
1869: Secretary of the Interior, *Ninth Census of the United States, 1870*, Vol. III, *The Statistics of the Wealth and Industry of the United States*, Washington, 1872, pp. 392, 394-398.
1879: Dept. of the Interior, *Tenth Census of the United States, 1880*, Vol. II, *Report on the Manufactures of the United States*, Washington, 1883, p. 501.
1889: Dept. of the Interior, *Eleventh Census of the United States, 1890*, Part I, *Report on Manufacturing Industries in the United States*, Washington, 1895, pp. 758-768.
1899A: Census Office, *Twelfth Census of the United States, 1900*, Vol. VII, Part I, *Manufactures, 1900*, Washington, 1902, pp. 582-595.
1899B: Dept. of Commerce and Labor, Bureau of the Census, *Manufactures, 1905*, Part IV, Washington, 1908, pp. 619-621, 627, 630, 636.
1909: Dept. of Commerce, Bureau of the Census, *Thirteenth Census of the United States, 1910*, Vol. VIII, *Manufactures, 1909*, Washington, 1913, pp. 341, 522-541.
1919: Dept. of Commerce, Bureau of the Census, *Fourteenth Census of the United States, 1920*, Vol. III, *Manufactures, 1919*, Washington, 1923, pp. 123-229.

CLASSIFICATION OF MANUFACTURING INDUSTRIES

One of the problems in analyzing power capacity by industry is to get comparable industry groups for the various Census dates. For 1838 to 1879, the industry classifications used here follow those of Robert Gallman. His two-digit classification scheme was based on the 1945 edition of the *Standard Industrial Classification Manual.* For the Censuses after 1879, the classifications, with adjustments necessary to achieve consistency with Gallman's groupings, were provided by Richard DuBoff, who based his classification scheme on that of Solomon Fabricant.[2]

To establish comparable industry groups, certain Census industries are not included in any of the major groups. Those industries have been included in Table A-2 under the heading of nonmanufacturing and are, for the most part, activities associated with agriculture, services, and mining. Since the objective of this work is to study power capacity in manufacturing, these industries, by definition, should be excluded from the totals, but they were included for two reasons. First, if the industries were excluded from the analysis by industry, then to achieve consistency they would also have to be excluded from the analysis by geographic division. To find the portion of each of the nonmanufacturing items in each state would have been difficult. Second, the amounts involved as a percentage of the total of each type of power at each Census date were

[2] Richard B. DuBoff, "Electric Power in American Manufacturing, 1880–1955," unpublished Ph.D. dissertation, University of Pennsylvania, 1963. Solomon Fabricant, *The Output of Manufacturing Industries, 1899–1937*, New York, NBER, 1940, Appendix C.

insignificant (Tables B-8 to B-11). Therefore, the totals in Tables A-1 and A-2 include data for a few activities not properly assignable to manufacturing.

NATURE OF BASIC DATA AND ADJUSTMENTS MADE FOR EACH CENSUS DATE

1838: The data on steam engines in 1838 is based on a study conducted by the Secretary of the Treasury in response to a June 1837 resolution of the House of Representatives. The House was interested in the use of steam engines in the United States and the accidents and loss of life or property attending their use. The Secretary, in turn, directed the collectors of customs to obtain the necessary information in their respective districts. The accuracy of the data thus depends in large part on the diligence of the individual collectors. There is a strong indication in the original House resolution and in the steps taken by the Secretary of the Treasury that the government made a genuine effort to insure the proper collection of information, although the limited time made available for the study led to incomplete returns.

The results of the study, which included information on steamboats and steam locomotives, as well as steam engines used in manufacturing, was presented in detail in House Executive Document 21.[3] Of the totals of 1,865 stationary steam engines and 36,068 horsepower reported, details were provided for 1,266 engines and 22,593 hp, while 599 engines and 13,475 hp were estimated either by the Secretary of the Treasury or the district collector of customs. Of these estimates, 244 engines and 4,880 hp represented an over-all estimate not assignable to any state or industry group, while 355 engines and 8,595 hp were assigned to particular states but with no additional details provided on the use of the engines. There is no specific reference made in the document to the basis used for the estimates.

Selection of the industry groups to which the engines should be assigned presented two problems. First, a few of the descriptions of the uses of the engines were not clear, and the best possible judgment, given the information presented, had to be made. The second problem was the assignment to industries of the 355 engines and 8,595 hp which were assigned to states, but for which the industry was not reported. The assignment of engines and horsepower made is shown in Table A-3, and the procedure used is described below.

1. For Louisiana and Pennsylvania, the horsepower and engines per industry in 1838, for which the industrial distribution was known, were

[3] House of Representatives, 25th Cong., 3d Sess., *Steam Engines*, H. Ex. Doc. 21, Washington, 1839, p. 305.

TABLE A-3

STATIONARY STEAM ENGINES AND TOTAL ESTIMATED HORSEPOWER,
AS ASSIGNED TO INDUSTRIES AND STATES, 1838

Major Group Number	Industry	Louisiana		Pennsylvania		Alabama		Missouri		New York		Other		Total		Percentage of Each Industry's Total Hp, Estimated
		No.	Hp	No.	Hp	No.	Hp	No.	Hp	No.	Hp	No.	Hp	No.	Hp	
20	Food and kindred products	139	4,070	2	38	20	400	28	560	17	384			206	5,452	55.8
21	Tobacco manufacture			--	1									--	1	2.7
22	Textile mill products	8	246	2	82					4	97			14	425	10.7
23	Apparel			--	6					1	17			1	23	5.4
24	Lumber and wood products	28	806	2	40	20	400	28	560	12	228			90	2,034	30.2
26	Pulp and paper products			1	11					--	2			1	13	2.7
28	Chemical and allied products			--	6					3	19			3	25	4.6
31	Leather and leather products			1	8					3	24			4	32	7.6
32	Stone, clay, and glass products			1	12					1	12			2	24	5.1
33	Primary metal industries			3	192									3	192	5.3
34	Fabricated metal products			--	3					2	15			2	18	6.6
35	Machinery			3	45					11	110			14	155	8.1
37	Transportation equipment			1	4					1	10			2	14	9.7
38	Instruments, etc., and miscellaneous			1	5					4	57			5	62	10.1
	Nonmanufacturing			1	52							7	73	8	125	7.5
	Total	175	5,122	18	505	40	800	56	1,120	59	975	7	73	355	8,595	23.8
	Percentage of each state's total hp, estimated	65.7		6.8		100.0		100.0		68.4		--		23.8		

used. The distribution of horsepower in 1869 in these two states indicated that no major Census industries had been left out in 1838. In fact, for Louisiana, the customs collector in 1838 specifically indicates that the estimate represents engines used in sugar mills, saw mills, and cotton gins.[4]

2. For Alabama and Missouri, there was no information on steam capacity by industry in 1838, but the use of steam power in 1870 provided a satisfactory basis for assigning 1838 engines and horsepower. A comparison of the 1840 and 1870 *Census of Manufacturing* showed that two of the major industries in these two states in 1840—flour and gristmill products and sawed lumber—were still the only significant industries, so far as steam-power capacity goes, in 1870. The assignment of 1838 engines and horsepower was based, therefore, on the almost equal distribution of steam power between these industries in 1870.

3. In New York, the basis was the distribution of workers by industry group in 1839 as reported in the 1840 Census.[5] The average steam horsepower available per worker in the United States in each industry group was found by dividing the known steam horsepower in each group in 1838 by the number of workers in each group in 1839. The results were multiplied by the number of workers in each group in 1839 in New York. These figures were then used as the basis for apportioning the 975 horsepower; the percentage of the total in each industry group was computed and applied to the 975 hp. For the industrial distribution of steam in New York in 1838, there was not enough information to supply a basis as in Louisiana and Pennsylvania. Instead, the distribution of engines was based on the 1838 average horsepower per engine in each major group in the United States.

4. In the rest of the states, the number of engines and amounts of horsepower were very small (7 engines, 73 horsepower, in total) and were arbitrarily assigned to the nonmanufacturing group. As mentioned previously, 244 engines and 4,880 horsepower were not assigned to any state or industry in the House document and, without further information, I classed them in Tables A-1 and A-2 as "not assignable."

The data for the decades from 1869 on are based on Census information. Certain problems encountered in use of the Census volumes and the methods used to deal with them are indicated below.

1869: In comparing horsepower capacity in the west central and mountain divisions (Table A-1) and the food and kindred products industry group (Table A-2), in 1869, to horsepower capacity at later

[4] H. Ex. Doc. 21.
[5] *Sixth Census, 1840*, pp. 358–364.

Census dates, it is necessary to take into account certain changes in the treatment of industries by the Bureau of the Census. The changes involve amounts that are not significant in relation to total horsepower capacity in 1869 but are significant within the divisions and industry groups.

In the 1869 Census, 18,296 horsepower of steam capacity in Louisiana was used for making sugar on plantations directly from raw cane. In 1879, steam engines used for that purpose were included by the Census Bureau in agriculture. Quartz milling was treated by the Bureau as part of manufacturing in 1869 and as part of mining after that date. In two

TABLE A-4

HORSEPOWER CAPACITY OF INDUSTRIES IN 1879 CENSUS

Industry Group of Census Industry	Census Industry	Water	Steam	Total
		(thous. hp)		
20	Flour and gristmill products; sugar and molasses, refined	470	322	792
22	Carpets, cotton goods, hosiery, silk, woolen, and worsted goods	218	211	429
24	Lumber, sawed	279	543	822
26	Paper	88	36	124
33	Iron and steel	17	381	397
35	Foundry and machine shop products, and agricultural implements	28	117	145

states, Montana and Nevada, quartz milling accounted for a significant portion of total steam- or water-power capacity in 1869—5,006 steam horsepower in Nevada and 596 steam horsepower in Montana. In addition, 2,168 horsepower of water was available in Nevada in 1869 for quartz milling. The decline in steam-power capacity in the mountain states between 1869 and 1879, shown in Table A-1, can be explained by the treatment of this Census industry.

1879: The 1879 Census gives horsepower capacity in only selected industries rather than for the whole range.[6] This created a comparability problem between the 1879 figures, by industry, and those for the other Census dates. Table A-4 gives the selected industries and the amounts of each type of power for which figures on power were provided. To estimate the percentage of total horsepower capacity in the respective industry group accounted for by these Census industries in 1879, the same industries were selected from the 1869 and 1889 Censuses, and their horsepower capacity for each type of power was expressed as a percentage

[6] *Tenth Census, 1880,* p. 502.

of the total in the industry group. The results are given in Table A-5. While these Census industries accounted for a large percentage of the horsepower capacity in their respective industry groups, perhaps even more important is the fact that, with only three exceptions—steam-power capacity in group 20 and water-power capacity in groups 26 and 33—the percentages were fairly constant over the twenty-year period.

In the computations by industry group in the tables in Appendix B, 1879 data are not included. It is possible, however, to develop an estimate of the horsepower capacity in these six industry groups by using the percentages indicated in Table A-5, which will be done in the larger study.

TABLE A-5

RATIO OF HORSEPOWER CAPACITY IN SELECTED CENSUS INDUSTRIES, REPORTED IN 1879, TO TOTAL HORSEPOWER CAPACITY IN THEIR RESPECTIVE INDUSTRY GROUPS, BY TYPE OF POWER, 1869 AND 1889

Industry Group	1869			1889		
	Water	Steam	All Primary Power	Water	Steam	All Primary Power
20	98.0	82.2	92.5	98.0	55.1	70.2
22	91.9	85.6	89.5	94.6	77.5	83.5
24	92.0	81.4	86.5	89.9	77.6	79.9
26	95.3	88.8	93.8	75.1	85.5	77.4
33	90.3	93.7	93.3	69.8	91.8	91.5
35	92.8	92.2	92.4	96.7	95.7	95.8

1899A-1899B: In 1905, the Bureau of the Census made a major revision in its industry coverage and retabulated 1899 data on a new basis. As a result, there are two sets of figures on power capacity in 1899. The 1899A figures should be used in making comparisons with dates prior to 1899, and the revised figures, 1899B, for comparisons with dates after 1899. The difference between the data in 1899A and 1899B is traceable to the treatment of custom and neighborhood establishments in three Census industries,[7] flour and gristmill (industry group 20), cotton gins (group 22), and lumber and timber (group 24). The effect of the exclusion of these custom and neighborhood establishments on power capacity is to reduce the total figure for steam capacity by about 7 per cent, water capacity by about 16 per cent, and total capacity by about 8 per cent. The exact effect of the exclusion on each geographic division and industry group can be seen by comparing the 1899A and 1899B columns in Tables A-1 and A-2.

[7] *Manufactures, 1905*, Part IV, Bureau of the Census, pp. 619–621.

Corrections were necessary in Table A-2, 1899A and 1899B, to obtain totals corresponding to those in Table A-1. The total electric horsepower figure in 1899A, by industry group, is 179,844 or 3,838 hp less than the total, by geographic division. The total by geographic division is probably correct, since it is higher than the 1899B electric horsepower figure given

TABLE A-6

PERCENTAGE DISTRIBUTION OF TOTAL STEAM-POWER CAPACITY IN MANUFACTURING, ENGINES AND TURBINES, 1919

Geographic Division	Per Cent	Major Group Number	Industry Group	Per Cent
United States	100.0	20	All manufacturing	100.0
North	72.1	20	Food and kindred products	12.0
New England	11.0	21	Tobacco manufacture	0.2
Middle Atlantic	30.8	22	Textile mill products	10.4
East north central	25.6	23	Apparel	0.4
West north central	4.7	24	Lumber and wood products	15.3
South	20.7	25	Furniture and fixtures	1.1
South Atlantic	9.4	26	Pulp, paper, and allied products	4.5
East south central	6.2	27	Printing, publishing, and allied products	0.3
West south central	5.1	28	Chemicals and allied products	4.5
West	7.2	29	Products of petroleum and coal	3.3
Mountain	2.3	30	Rubber products	1.3
Pacific	4.9	31	Leather and leather products	1.3
State		32	Stone, clay, and glass products	5.9
Pennsylvania	18.6	33	Primary metal industries	27.3
Ohio	10.5	34	Fabricated metal products	1.8
New York	7.6	35	Machinery	3.3
Illinois	5.9	36	Electric machinery	1.3
Massachusetts	5.7	37	Transportation equipment	4.8
Louisiana	1.9	38	Professional instruments, etc., and miscellaneous	1.0
Virginia	1.5		Nonmanufacturing	0.1
Total, top 5	48.3			
Total, top 7	51.7			
Total, all others	48.3			

in the 1905 Census volume—which excludes some custom and neighborhood establishments—rather than lower as the industry total figure is. In 1899B, the adjustment of the total steam-power figure is made necessary by the fact that, in excluding the custom and neighborhood establishments from the three industry groups mentioned earlier, there is a reduction in the total of 605,838 hp, while the actual difference between total steam-power capacity in 1899A and 1899B is only 601,859 hp. The total for gas in 1899B compared with 1899A declined but, since there was no basis given for correcting the individual industry groups, the adjustment item was used. The total for electric horsepower in 1899B was adjusted to

agree with the 1899B total purchased electric horsepower figure given in the Census volume.

1909 and 1919: Before 1919, steam turbines were not recorded separately in the Census. Since these turbines were first used after the turn of the century, and the major growth in their use was between 1909 and 1919, the amount of steam power represented by turbines in the 1909 Census figure is relatively insignificant. It would be preferable in studying the changes in the use of steam power to keep steam turbines and steam engines separate. The turbines were used to produce electric energy to run electric motors and thus really represent a movement away from steam, or at least a change in the way steam was used as a source of power. In the Appendix B tables, turbines are not included in the figures on steam in 1919. However, although the relative amount is small, the 1909 figures do contain horsepower representing steam turbines. To indicate the effect on the comparison of 1909 and 1919 data of the inclusion of steam turbines in the 1919 computations, I have recomputed the 1919 columns in Tables B-5, B-6, and B-10. The change in the percentages caused by the inclusion of turbines is relatively small, as is evident in Table A-6.

In Tables B-12 and B-13, it is only necessary to add together the steam and steam turbine columns for 1919 to get the percentage directly comparable with 1909. The inclusion of turbines here does not alter the basic conclusion that steam was declining in importance as a source of power in each geographic division and industry group.

Appendix B

TABLE B-1

AVERAGE PERCENTAGE RATE OF CHANGE PER DECADE OF PRIMARY-POWER CAPACITY IN MANUFACTURING, BY TYPE, 1838-1919

Type of Power	1838-69	1869-79	1879-89	1889-99A	1899B-1909	1909-19
Total primary power	n.a.	45.4	71.4	84.7	86.9	58.8
Steam[a]	223.0	79.8	109.6	90.8	74.4	20.0
Water	n.a.	8.4	2.4	37.6	25.4	-3.2
Electric (purch.)	0	0	0	0	858.0	434.4
Gas	0	0	0	1,511.0	457.5	67.7

Source: Tables A-1 and A-2.

[a]Includes steam turbines.

TABLE B-2

PERCENTAGE DISTRIBUTION OF PRIMARY-POWER CAPACITY IN MANUFACTURING, BY TYPE, 1869-1919

Type of Power	1869	1879	1889	1899A	1899B	1909	1919
Total primary power	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Steam	51.8	64.1	78.4	81.0	82.1	76.7	47.1
Water	48.2	35.9	21.5	16.0	14.7	9.8	6.0
Electric (purch.)	0	0	0	1.7	1.8	9.4	31.8
Gas	0	0	0.2	1.3	1.4	4.1	4.3
Steam turbines	0	0	0	0	0	0	10.9

Source: Table A-1.

TABLE B-3

PERCENTAGE DISTRIBUTION OF TOTAL PRIMARY-POWER CAPACITY IN MANUFACTURING, BY GEOGRAPHIC DIVISION, 1869-1919

Geographic Division	1869	1879	1889	1899A	1899B	1909	1919
United States	100.0	100.0	100.0	100.0	100.0	100.0	100.0
North	82.1	83.3	81.2	75.1	78.5	73.3	73.4
New England	21.9	21.8	19.4	16.7	17.7	14.4	12.9
Middle Atlantic	32.2	31.3	32.5	29.4	30.9	29.5	28.9
East north central	22.6	23.7	22.4	23.0	23.9	23.5	26.2
West north central	5.4	6.5	6.9	6.0	6.0	5.9	5.4
South	15.5	14.8	15.5	21.3	17.6	20.1	18.3
South Atlantic	8.9	8.6	8.0	9.5	8.4	9.8	9.5
East south central	4.6	4.5	5.2	6.3	5.2	5.6	4.8
West south central	2.0	1.7	2.3	5.5	4.0	4.7	4.0
West	2.3	2.0	3.3	3.6	3.9	6.5	8.3
Mountain	0.7	0.5	0.8	1.1	1.2	2.2	2.3
Pacific	1.6	1.5	2.5	2.5	2.7	4.3	6.0

Source: Table A-1.

TABLE B-4

PERCENTAGE DISTRIBUTION OF TOTAL WATER-POWER CAPACITY IN MANUFACTURING, BY GEOGRAPHIC DIVISION, 1869-1919

Geographic Division	1869	1879	1889	1899A	1899B	1909	1919
United States	100.0	100.0	100.0	100.0	100.0	100.0	100.0
North	81.9	82.3	83.3	80.9	86.2	83.4	84.4
New England	32.0	34.5	39.6	38.0	42.6	41.5	42.4
Middle Atlantic	33.3	29.1	26.5	27.8	28.2	25.8	22.4
East north central	13.3	12.9	12.4	11.3	11.8	11.4	14.3
West north central	3.3	5.8	4.8	3.8	3.6	4.7	5.3
South	16.3	15.8	14.8	16.0	10.5	11.8	11.4
South Atlantic	12.4	11.9	11.6	12.2	8.6	10.0	9.8
East south central	3.6	3.5	2.8	3.4	1.7	1.6	1.4
West south central	0.3	0.4	0.4	0.4	0.2	0.2	0.2
West	1.8	1.9	2.0	3.2	3.3	4.7	4.2
Mountain	0.6	0.7	0.5	1.2	1.2	1.2	0.9
Pacific	1.2	1.2	1.5	2.0	2.1	3.5	3.3

Source: Table A-1.

TABLE B-5

PERCENTAGE DISTRIBUTION OF TOTAL STEAM-POWER CAPACITY IN MANUFACTURING, BY GEOGRAPHIC DIVISION, 1838-1919

Geographic Division	1838	1869	1879	1889	1899A	1899B	1909	1919
United States	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
North	48.3	82.5	83.8	80.6	73.5	76.8	71.4	70.0
New England	13.5	12.6	14.7	13.8	12.6	13.4	11.7	9.8
Middle Atlantic	25.6	31.3	32.5	34.2	29.4	31.1	29.2	30.6
East north central	6.1	31.3	29.8	25.1	25.2	26.0	24.6	24.5
West north central	3.1	7.3	6.8	7.5	6.3	6.3	5.9	5.1
South	38.2	14.9	14.2	15.7	22.8	19.3	22.5	22.5
South Atlantic	14.4	5.8	6.8	7.0	9.1	8.6	10.1	10.0
East south central	2.2	5.6	5.0	5.8	7.0	5.9	6.7	6.6
West south central	21.6	3.5	2.4	2.9	6.7	4.8	5.7	5.9
West	0	2.6	2.0	3.6	3.6	3.9	6.2	7.5
Mountain	0	0.8	0.4	0.9	1.1	1.2	2.2	2.3
Pacific	0	1.8	1.6	2.7	2.5	2.7	4.0	5.2
Not assignable	13.5	0	0	0	0	0	0	0

Source: Table A-1.

TABLE B-6

PERCENTAGE DISTRIBUTION OF TOTAL STEAM-POWER CAPACITY IN MANUFACTURING, BY STATE, 1838–1919
(top 5 states at each date)

State	1838	1869	1899B	1919
United States	100.0	100.0	100.0	100.0
Pennsylvania	20.6	18.3	19.5	18.8
Ohio	5.0	10.7	9.0	10.2
New York	4.0	10.4	8.1	7.6
Illinois	0	6.0	6.2	5.6
Massachusetts	6.2	6.5	7.1	5.0
Louisiana	21.6	2.1	2.3	2.3
Virginia	4.3	.7	1.3	1.5
Total, top 5	57.7	51.9	49.9	47.2
Total, all 7	61.7	54.7	53.5	51.0
Total, all others	38.3[a]	45.3	46.5	49.0

Source: Data for individual states will appear in subsequent study.

[a]Includes item noted in Tables A-1 and A-2 as not assignable.

TABLE B-7

PERCENTAGE DISTRIBUTION OF TOTAL PURCHASED ELECTRIC-POWER CAPACITY IN MANUFACTURING, BY GEOGRAPHIC DIVISION, 1899–1919

Geographic Division	1899B	1909	1919
United States	100.0	100.0	100.0
North	82.8	73.1	73.2
New England	17.3	12.5	12.1
Middle Atlantic	40.7	32.5	26.3
East north central	16.8	21.5	28.4
West north central	8.0	6.6	6.4
South	7.1	13.8	15.1
South Atlantic	2.8	9.8	9.5
East south central	2.1	2.2	3.3
West south central	2.2	1.8	2.3
West	10.1	13.1	11.7
Mountain	2.2	3.8	2.8
Pacific	7.9	9.3	8.9

Source: Table A-1.

TABLE B-8

PERCENTAGE DISTRIBUTION OF TOTAL PRIMARY-POWER CAPACITY IN MANUFACTURING, BY INDUSTRY GROUP, 1869-1919

Major Group Number	Industry Group	1869	1889	1899A	1899B	1909	1919
	All Manufacturing	100.0	100.0	100.0	100.0	100.0	100.0
20	Food and kindred products	27.8	19.0	17.3	15.7	13.4	12.1
21	Tobacco manufacture	0.1	0.2	0.2	0.2	0.2	0.1
22	Textile products	12.0	14.9	15.3	13.5	11.5	10.4
23	Apparel	0.6	0.5	0.6	0.7	0.8	0.7
24	Lumber and wood products	31.6	20.5	18.2	17.1	16.1	10.4
25	Furniture and fixtures	1.3	1.5	1.2	1.3	1.4	1.1
26	Pulp, paper, and allied products	2.4	5.3	7.3	8.0	7.4	6.8
27	Printing, publishing, and allied industries	0.4	0.9	1.0	1.1	1.6	1.3
28	Chemicals and allied products	1.6	3.1	3.2	3.5	4.0	4.3
29	Products of petroleum and coal	0.3	1.1	0.9	1.0	1.5	2.7
30	Rubber products	0.3	0.5	0.7	0.7	0.7	1.5
31	Leather and leather products	1.9	1.6	1.4	1.5	1.4	1.3
32	Stone, clay, and glass products	1.4	3.9	5.4	5.9	6.9	6.3
33	Primary metal industries	9.6	14.1	16.3	17.8	20.0	22.0
34	Fabricated metal products	2.3	2.9	1.8	2.0	1.8	3.0
35	Machinery	3.5	4.5	4.2	4.5	5.3	5.5
36	Electric machinery	—	0.1	0.4	0.4	0.9	1.6
37	Transportation equipment	1.2	2.4	2.7	3.0	4.1	7.1
38	Professional instruments, etc., and miscellaneous	0.6	0.9	0.8	0.9	1.1	1.2
	Nonmanufacturing	1.0	2.0	.9	1.0	—	0.5
	Adjustment	0	0	—	—	0	0

Source: Table A-2.

TABLE B-9

PERCENTAGE DISTRIBUTION OF TOTAL WATER-POWER CAPACITY IN MANUFACTURING, BY INDUSTRY GROUP, 1869-1919

Major Group Number	Industry Group	1869	1889	1899A	1899B	1909	1919
	All Manufacturing	100.0	100.0	100.0	100.0	100.0	100.0
20	Food and kindred products	36.9	31.2	26.8	17.5	15.1	11.2
21	Tobacco manufacture	--	--	--	--	--	--
22	Textile products	15.6	24.1	22.5	26.0	24.3	25.4
23	Apparel	0.3	0.2	0.2	0.3	0.3	0.2
24	Lumber and wood products	31.4	17.7	12.9	11.5	8.3	4.2
25	Furniture and fixtures	1.0	0.7	0.4	0.5	0.4	0.3
26	Pulp, paper, and allied products	3.9	16.4	29.3	34.8	43.5	51.9
27	Printing, publishing, and allied industries	--	0.2	0.2	0.2	0.1	0.1
28	Chemicals and allied products	0.6	0.9	0.7	0.8	1.0	0.6
29	Products of petroleum and coal	--	--	--	--	0.2	--
30	Rubber products	0.2	0.3	0.3	0.4	0.3	0.3
31	Leather and leather products	1.4	0.6	0.3	0.4	0.3	0.3
32	Stone, clay, and glass products	0.8	0.6	1.1	1.3	1.3	1.3
33	Primary metal industries	2.5	0.9	1.5	1.8	1.5	1.2
34	Fabricated metal products	1.5	1.7	1.1	1.3	1.0	0.8
35	Machinery	2.0	2.1	1.6	1.9	1.5	1.4
36	Electric machinery	--	--	0.1	0.1	0.1	0.1
37	Transportation equipment	0.7	0.5	0.4	0.5	0.3	0.2
38	Professional instruments, etc., and miscellaneous	0.4	0.5	0.3	0.4	0.4	0.4
	Nonmanufacturing	0.6	1.4	0.3	0.3	--	0.1

Source: Table A-2.

TABLE B-10

PERCENTAGE DISTRIBUTION OF TOTAL STEAM-POWER CAPACITY IN MANUFACTURING, BY INDUSTRY GROUP, 1838-1919

Major Group Number	Industry Group	1838	1869	1889	1899A	1899B	1909	1919
	All Manufacturing	100.0	100.0	100.0	100.0	100.0	100.0	100.0
20	Food and kindred products	27.1	19.3	15.6	15.5	15.1	13.5	13.5
21	Tobacco manufacture	0.1	0.2	0.3	0.3	0.3	0.2	0.2
22	Textile products	11.0	8.5	12.4	14.3	11.7	10.6	9.6
23	Apparel	1.2	0.9	0.6	0.5	0.6	0.5	0.5
24	Lumber and wood products	18.7	31.8	21.3	19.8	19.1	19.1	17.6
25	Furniture and fixtures	0.1	1.5	1.7	1.4	1.5	1.5	1.3
26	Pulp, paper, and allied products	1.4	1.1	2.2	3.2	3.4	3.6	4.4
27	Printing, publishing, and allied industries	0.1	0.7	1.1	0.6	0.7	0.4	0.3
28	Chemicals and allied products	1.5	2.6	3.7	3.6	3.9	4.0	4.3
29	Products of petroleum and coal	0	0.6	1.4	1.1	1.2	1.8	2.7
30	Rubber products	0.1	0.4	0.5	0.7	0.8	0.8	0.9
31	Leather and leather products	1.2	2.3	1.8	1.5	1.6	1.5	1.4
32	Stone, clay, and glass products	1.3	2.0	4.9	6.3	6.8	7.3	6.4
33	Primary metal industries	10.0	16.2	17.8	19.8	21.2	23.4	25.8
34	Fabricated metal products	0.8	3.1	3.3	1.8	1.9	1.5	1.9
35	Machinery	5.3	4.8	5.1	4.4	4.8	4.5	3.2
36	Electric machinery	0	0	0.1	0.4	0.4	0.7	0.5
37	Transportation equipment	0.4	1.7	3.0	3.2	3.4	4.1	4.4
38	Professional instruments, etc., and miscellaneous	1.7	0.8	1.0	0.8	0.9	1.0	1.0
	Nonmanufacturing	4.6	1.4	2.2	0.8	0.9	--	0.1
	Not assignable	13.5	0	0	0	0	0	0
	Adjustment	0	0	0	--	--	0	0

Source: Table A-2.

TABLE B-11

PERCENTAGE DISTRIBUTION OF TOTAL PURCHASED ELECTRIC-POWER CAPACITY IN MANUFACTURING, BY INDUSTRY GROUP, 1899-1919

Major Group Number	Industry Group	1899B	1909	1919
	All Manufacturing	100.0	100.0	100.0
20	Food and kindred products	10.6	10.5	12.2
21	Tobacco manufacture	0.3	0.3	0.2
22	Textile products	5.3	9.2	9.0
23	Apparel	7.0	3.1	1.4
24	Lumber and wood products	2.4	4.1	3.4
25	Furniture and fixtures	1.8	1.8	1.2
26	Pulp, paper, and allied products	1.1	3.2	3.3
27	Printing, publishing, and allied industries	19.0	11.6	3.3
28	Chemicals and allied products	11.7	7.9	4.9
29	Products of petroleum and coal	0.1	1.0	2.1
30	Rubber products	0.1	0.5	2.1
31	Leather and leather products	3.6	2.3	1.5
32	Stone, clay, and glass products	2.6	7.3	7.5
33	Primary metal industries	2.3	7.7	13.2
34	Fabricated metal products	9.0	3.8	5.7
35	Machinery	8.5	12.4	10.2
36	Electric machinery	2.7	2.9	2.7
37	Transportation equipment	3.4	8.0	13.2
38	Professional instruments, etc., and miscellaneous	3.3	2.5	2.0
	Nonmanufacturing	3.8	0	1.1
	Adjustment	1.1	0	0

Source: Table A-2.

TABLE B-12

PERCENTAGE DISTRIBUTION OF PRIMARY-POWER CAPACITY IN MANUFACTURING, BY TYPE AND GEOGRAPHIC DIVISION, 1869-1919

Geographic Division	1869		1879		1889			1899A			
	Water	Steam	Water	Steam	Water	Steam	Gas	Water	Steam	Gas	Electric (purch.)
United States	48.2	51.8	35.9	64.1	21.5	78.4	0.2	16.0	81.0	1.3	1.7
New England	70.3	29.7	56.9	43.1	43.9	56.0	0.1	36.5	61.2	0.6	1.8
Middle Atlantic	49.7	50.3	33.4	66.6	17.5	82.4	0.2	15.1	81.0	1.5	2.3
East north central	28.2	71.8	19.5	80.5	11.9	88.0	0.2	7.8	89.0	1.9	1.2
West north central	29.4	70.6	32.2	67.8	14.8	85.0	0.2	10.1	84.5	3.1	2.3
South Atlantic	66.6	33.4	49.5	50.5	31.2	68.6	0.2	20.6	78.2	0.7	0.5
East south central	37.3	62.7	28.0	72.0	11.5	88.4	0.1	8.7	90.3	0.4	0.6
West south central	7.7	92.3	8.0	92.0	3.3	96.4	0.3	1.2	97.7	0.4	0.7
Mountain	43.3	56.7	51.2	48.8	14.4	85.3	0.2	16.4	79.3	1.0	3.3
Pacific	38.6	61.4	30.0	70.0	13.3	86.4	0.3	12.3	81.1	1.3	5.3

	1899B				1909				1919				
	Water	Steam	Gas	Electric (purch.)	Water	Steam	Gas	Electric (purch.)	Water	Steam	Gas	Electric (purch.)	Steam Turbine
United States	14.7	82.1	1.4	1.8	9.8	76.7	4.1	9.4	6.0	47.1	4.3	31.8	10.9
New England	35.3	62.3	.6	1.8	28.3	61.9	1.6	8.2	19.8	35.9	.9	29.9	13.5
Middle Atlantic	13.4	82.7	1.5	2.4	8.6	76.0	5.0	10.4	4.7	49.7	4.8	28.8	12.0
East north central	7.2	89.6	1.9	1.3	4.8	80.1	6.5	8.6	3.3	44.0	5.6	34.5	12.6
West north central	8.7	85.9	3.0	2.4	7.9	76.4	5.2	10.5	5.8	44.4	6.4	37.4	5.9
South Atlantic	14.9	83.6	0.8	0.6	10.1	78.6	2.0	9.4	6.2	49.7	4.9	31.8	7.4
East south central	4.9	93.9	0.4	0.7	2.8	92.2	1.2	3.7	1.8	64.5	1.6	22.0	10.1
West south central	.7	97.8	0.5	1.0	.4	92.6	3.4	3.7	.3	68.9	6.9	18.5	5.4
Mountain	15.0	80.7	1.0	3.3	5.4	76.8	1.0	16.8	2.3	47.0	1.5	37.9	11.3
Pacific	11.4	81.9	1.3	5.3	7.9	70.3	1.5	20.3	3.3	41.2	1.9	47.4	6.2

Source: Table A-1.

TABLE B-13

PERCENTAGE DISTRIBUTION OF PRIMARY-POWER CAPACITY IN MANUFACTURING, BY TYPE, ALL MANUFACTURING AND EACH INDUSTRY GROUP, 1869-1919

Major Group Number	Industry Group	1869		1889			1899A			
		Water	Steam	Water	Steam	Gas	Water	Steam	Gas	Electric (purch.)
	All Manufacturing	48.2	51.8	21.5	78.4	0.2	16.0	81.0	1.3	1.7
20	Food and kindred products	63.9	36.1	35.3	64.6	0.1	24.7	72.6	1.7	1.0
21	Tobacco manufacture	13.0	87.0	0.4	98.6	1.0	1.8	94.7	1.5	1.9
22	Textile products	63.0	37.0	34.7	65.2	0.1	23.5	75.8	0.2	0.6
23	Apparel	24.4	75.6	7.8	89.8	2.4	5.4	68.4	8.0	18.2
24	Lumber and wood products	47.9	52.1	18.6	81.4	0	11.3	87.9	0.5	0.2
25	Furniture and fixtures	38.9	61.1	10.9	88.9	0.2	5.8	89.6	2.1	2.5
26	Pulp, paper, and allied products	77.0	23.0	66.0	33.9	0.1	64.1	35.3	0.3	0.3
27	Printing, publishing, and allied industries	1.5	98.5	4.8	89.8	5.3	2.6	51.2	14.3	31.9
28	Chemicals and allied products	17.8	82.2	6.4	93.4	0.2	3.5	89.6	0.8	6.1
29	Products of petroleum and coal	1.6	98.4	0.1	99.8	0.1	--	98.7	1.1	0.2
30	Rubber products	29.7	70.3	12.1	87.9	--	7.5	92.2	--	0.3
31	Leather and leather products	36.8	63.2	8.1	91.2	0.6	3.9	89.6	2.1	4.4
32	Stone, clay, and glass products	26.7	73.3	3.1	96.9	--	3.2	94.8	1.2	0.8
33	Primary metal industries	12.8	87.2	1.4	98.6	--	1.5	98.0	0.3	0.2
34	Fabricated metal products	30.4	69.6	12.0	87.7	0.3	9.7	78.0	4.0	8.3
35	Machinery	28.3	71.7	10.3	89.5	0.2	6.2	85.8	4.5	3.5
36	Electric machinery	100.0	0	1.9	98.1	--	2.1	81.9	4.4	11.7
37	Transportation equipment	28.6	71.4	4.1	95.7	0.2	2.3	93.5	2.2	2.1
38	Professional instruments, etc., and miscellaneous	33.3	66.7	12.3	86.6	1.0	6.6	82.0	4.5	6.9

(continued)

TABLE B-13 (concluded)

Major Group Number	Industry Group	1899B				1909				1919				
		Water	Steam	Gas	Electric (purch.)	Water	Steam	Gas	Electric (purch.)	Water	Steam	Gas	Electric (purch.)	Steam Turbine
	All Manufacturing	14.7	82.1	1.4	1.8	9.8	76.7	4.1	9.4	6.0	47.1	4.3	31.8	10.9
20	Food and kindred products	16.5	80.2	2.0	1.2	11.1	77.4	4.1	7.4	5.5	52.6	5.2	32.0	4.7
21	Tobacco manufacture	1.8	94.7	1.5	1.9	0.9	77.4	2.8	18.9	0.9	59.6	0.8	33.3	5.4
22	Textile products	28.2	70.8	0.2	0.7	20.8	71.0	0.6	7.5	14.6	43.1	0.4	27.4	14.5
23	Apparel	5.4	68.4	8.0	18.2	3.6	51.0	7.3	38.1	1.8	32.3	2.0	62.8	1.0
24	Lumber and wood products	9.7	89.5	0.6	0.3	5.1	91.0	1.5	2.4	2.4	80.0	1.7	10.3	5.6
25	Furniture and fixtures	5.8	89.6	2.1	2.5	2.9	81.6	3.4	12.1	1.7	55.0	2.3	36.0	5.0
26	Pulp, paper, and allied products	64.1	35.3	0.3	0.3	57.7	37.4	0.7	4.1	46.0	30.8	0.3	15.3	7.6
27	Printing, publishing and allied products	2.6	51.2	14.3	31.9	0.8	20.1	11.0	68.2	0.3	12.2	4.6	82.6	0.3
28	Chemicals and allied products	3.5	89.6	0.8	6.1	2.5	76.8	1.9	18.8	0.8	47.4	2.7	35.9	13.3
29	Products of petroleum and coal	—	98.7	1.1	0.2	1.2	87.5	5.1	6.2	—	45.5	6.6	24.6	23.3
30	Rubber products	7.5	92.2	—	0.3	4.1	86.9	1.9	7.0	1.3	28.1	0.9	45.0	24.7
31	Leather and leather products	3.9	89.6	2.1	4.4	2.2	77.9	4.7	15.2	1.2	49.3	2.2	37.6	9.8
32	Stone, clay, and glass products	3.2	94.8	1.2	0.8	1.9	82.1	6.0	10.0	1.2	47.6	6.8	37.7	6.6
33	Primary metal industries	1.5	98.0	0.3	0.2	0.7	89.7	5.9	3.7	0.3	55.3	8.6	19.1	16.7
34	Fabricated metal products	9.7	78.0	4.0	8.3	5.6	64.8	9.8	19.7	1.7	29.8	4.3	59.4	4.9
35	Machinery	6.2	85.8	4.5	3.5	2.8	64.7	10.4	22.0	1.5	27.1	5.0	59.0	7.4
36	Electric machinery	2.1	81.9	4.4	11.7	0.7	64.4	4.1	30.8	0.4	15.0	1.6	53.0	30.0
37	Transportation equipment	2.3	93.5	2.2	2.1	0.8	76.6	4.4	18.2	0.1	29.3	1.8	58.9	9.8
38	Professional instruments, etc., and miscellaneous	6.6	82.0	4.5	6.9	3.8	67.9	7.2	21.1	1.9	38.6	3.3	50.1	6.1

Source: Table A-2.