

146  
REFERENCE COPY

DEPARTMENT OF THE INTERIOR,  
CENSUS OFFICE.

FRANCIS A. WALKER, Superintendent,  
Appointed April 11, 1879; resigned November 3, 1881.

CHAS. W. SEATON, Superintendent,  
Appointed November 4, 1881. Office of Superintendent  
abolished March 3, 1885.

REPORT

ON

POWER AND MACHINERY EMPLOYED IN MANUFACTURES,

EMBRACING

STATISTICS OF STEAM AND WATER POWER USED IN THE MANUFACTURE  
OF IRON AND STEEL, MACHINE TOOLS AND WOOD-WORKING  
MACHINERY, WOOL AND SILK MACHINERY,

AND MONOGRAPHS ON

PUMPS AND PUMPING ENGINES, MANUFACTURE OF ENGINES AND BOILERS, MARINE  
ENGINES AND STEAM VESSELS.

PROF. W. P. TROWBRIDGE,

CHIEF SPECIAL AGENT.

ALSO

REPORT ON THE ICE INDUSTRY OF THE UNITED STATES,

BY

HENRY HALL,

SPECIAL AGENT.



WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1888.  
BUREAU OF THE CENSUS

## LETTER OF TRANSMITTAL.

---

DEPARTMENT OF THE INTERIOR,  
OFFICE OF THE SECRETARY,  
*Washington, D. C., June 1, 1888.*

SIR: I have the honor to transmit herewith the twenty-second and last volume of the series constituting the final report on the Tenth Census. It consists of seven distinct reports, as follows:

Steam and Water Power used in the Manufacture of Iron and Steel; Machine Tools and Wood-working Machinery; Wool and Silk Machinery; Pumps and Pumping Engines; Manufacture of Engines and Boilers, and Marine Engines and Steam Vessels, compiled under the direction of Professor W. P. Trowbridge, of the School of Mines, Columbia College, New York, chief special agent; and a report upon the Ice Industry of the United States, by Henry Hall, of New York, a special agent of the Census Office.

I have the honor to be, very respectfully,

JAMES H. WARDLE,  
*Chief of Census Division.*

HON. WILLIAM F. VILAS,  
*Secretary of the Interior.*

# GENERAL TABLE OF CONTENTS.

---

## GENERAL LETTER OF TRANSMITTAL.

By Professor W. P. TROWBRIDGE, *Chief Special Agent.*

## STATISTICS OF STEAM AND WATER POWER USED IN THE MANUFACTURE OF IRON AND STEEL.

By HERMAN HOLLERITH, E. M., *Special Agent.*

## MACHINE TOOLS AND WOOD-WORKING MACHINERY.

By F. R. HUTTON, M. E., *Special Agent.*

## WOOL AND SILK MACHINERY.

By KNIGHT NEFTEL, C. E., *Special Agent.*

## PUMPS AND PUMPING ENGINES.

By F. R. HUTTON, M. E., *Special Agent.*

## MANUFACTURE OF ENGINES AND BOILERS.

By CHARLES H. FITCH, D. E., *Special Agent.*

## MARINE ENGINES AND STEAM VESSELS.

By CHARLES H. FITCH, D. E., *Special Agent.*

## REPORT ON THE ICE INDUSTRY OF THE UNITED STATES.

By HENRY HALL, *Special Agent.*

## LETTER OF TRANSMITTAL.

NEW YORK, N. Y., September 25, 1882.

Hon. CHAS. W. SEATON,  
*Superintendent of Census, Washington, D. C. :*

SIR: I have the honor to transmit herewith the following reports of special agents of the Census acting under my supervision and direction in obtaining statistics of "Power and Machinery," to wit:

1. The report of Mr. Herman Hollerith on "Steam and Water Power used in the Manufacture of Iron and Steel."
2. The report of Mr. F. R. Hutton on "Machine Tools and Wood-Working Machinery."
3. The report of Mr. F. R. Hutton on "Pumps and Pumping Engines."
4. The report of Mr. Knight Neftel on "Wool and Silk Machinery."
5. The report of Mr. C. H. Fitch on "Engines and Boilers."
6. The report of Mr. C. H. Fitch on "Marine Engines and Steam Vessels."

These reports exhibit the conditions of the industries to which they relate at the present period in the history of this country.

The report of Mr. Hollerith will be found interesting as showing the gradual increase in the proportion of steam-power over water-power, notwithstanding the increase in the latter. It is not difficult to find reasons for this. In the first place, water-power is not always, nor indeed usually, found conveniently located for the erection of large manufacturing establishments. Accessibility to lines of communication is an important element in connection with the building up of extensive establishments in which power is used, and although many notable instances are found where the water-power afforded by large streams is so favorably located in all respects that manufacturing towns have grown up in the immediate vicinity, supported mainly by the water-power available, yet the general rule in regard to water-power, from the very nature of this power, is a certain degree of isolation and inaccessibility; whereas steam-power is not restricted by the topographical features of a country nor to definite localities.

In the second place, water-power is generally limited in amount and irregular, at any one locality, depending, as it does, upon changeable hydrological conditions; while steam-power may not only be indefinitely increased at any point, but may be made regular and constant from day to day, winter and summer. A large part of the increase in steam-power for certain kinds of manufactures is therefore found to be auxiliary or supplementary to established water-powers, either for the purpose of adding power or for supplying the occasional or periodical deficiencies of water-power.

In this connection I would refer to the reports of Mr. George F. Swain, Mr. James L. Greenleaf, and Mr. Dwight Porter, on the water-power of the whole country, including that which has been utilized and that which is available.

The relative cost of steam-power and water-power in different parts of the country was one of the questions proposed in Mr. Hollerith's investigations, but without much hope of any definite solution. It was apparent from the first that the costs of these two kinds of power have no relation to each other; the cost of steam-power depending upon the cost of plant, fuel, and engineers' wages, mainly, while the cost of water-power depends upon the cost of dams, supply-conduits, and hydraulic motors. The cost of either for any particular locality can thus be determined under local conditions and circumstances only.

The report of Mr. Hutton on "Machine Tools and Wood-Working Machinery" furnishes a condensed but sufficiently comprehensive statement and exposition of the condition of the arts covered by these important aids to industry in this country at the present time.

The two features which are of the greatest importance in American manufacturing industries are the development and general introduction of the principle of interchangeability in the parts of machines and implements

manufactured and employed in the country, and the gradual introduction into our machine-shops and factories of special tools for preparing and shaping materials for the special uses which they are to subserve, either as parts of such machines or implements, or for general use.

These two branches or lines of development are closely related to each other, and have exercised an immense influence in the rapid growth of our national interests. It may be said of both that they had their origin in the characteristic inventive genius of our people, which has been wisely fostered by the national legislature through liberal patent laws enacted from time to time.

Within the memory of men now living, a New England farmer has devoted his winter evenings to the making of wooden clocks for sale, his implements being a knife, a file, and a saw; another has devoted himself, with the aid of his family, to covering buttons by hand; the modest products in each case going far toward the support of the family. The same processes are now accomplished, with great improvement in style and materials, on a large scale in extensive establishments provided with special tools which render hand-work almost unnecessary. These are mere instances to illustrate the changes that have taken place in every branch of human labor through the introduction of special devices now employed in manufacturing.

In the treatment of the materials which form the heavier metallic parts of engines and other machinery, and all varieties of wood-work, the advance has been no less remarkable. Operations now performed at small cost in preparing such materials for use would have been found impossible a few years ago by mere hand-work, or would at least have been impracticable on account of the great expense involved.

It may be affirmed, moreover, that with the multiplication of general and special tools in shops and factories there has been a corresponding advance in the strength, durability, and reliability of the machines and implements produced. The exact time-tables of our railway systems, fulfilled with such wonderful certainty at the present day, and the comparative immunity from stoppages and accidents of our manufacturing and mining machinery, would be unknown elements of modern activity if the machines employed were made wholly by hand.

The heavy operations now employed in welding, turning, boring, and shaping would be impracticable without the modern tools employed for these purposes. Without the steam-hammer the modern propeller-shaft for steamships could not be made, while there are hundreds of operations which, though possible by hand, are commercially practicable only through special tools.

The desire of General F. A. Walker, late Superintendent of Census, that the subject of shop-tools and wood-working machinery should receive attention in connection with the statistics of power and machinery led me to secure the services of Mr. F. R. Hutton, assistant in mechanical engineering in the School of Mines, Columbia College, New York, for this special work. Mr. Hutton's acquirements and fitness for this work were well known to me, and I now transmit his report, together with sketches, drawings, cuts, etc., relating to and illustrating the same.

The report will, I believe, be found worthy of a place in the records of the Tenth Census as illustrating the present period of our country's progress in the mechanic arts.

The report of Mr. Hutton on Pumps and Pumping Engines will, I am sure, commend itself to the mechanical engineers of the country. The modern steam-pump is comparatively a recent and exclusively an American invention. It has been copied abroad and has been brought into almost universal use. Variations in details have been introduced by many skillful American inventors, and their numerous designs applicable to pumping with equal facility large and small quantities of water, with lifts from a few feet to many hundred feet, render the American pump one of the most valuable of modern inventions.

The report of Mr. Neftel on Wool and Silk Machinery deals with very old processes in which radical improvements, except in minor details, are hardly to be expected, but the report will be found to contain much that is interesting. Mr. Neftel's report on Flour-milling Machinery has already been transmitted and is published in Vol. III of the final report on Tenth Census.

To the reports of Mr. Fitch, which have already been transmitted, I have now to add his reports on Stationary Engines and Boilers and Marine Engines and Vessels.

The former covers a branch of industry in manufacturing and the application of steam-power in which it is universally acknowledged that this country has taken the lead, while the latter report will be found to contain descriptions of marine engines and vessels of types peculiar to our inland waters, prepared for publication in a form suitable for conveying general information on these subjects which is not generally accessible.

I beg to add, in closing this brief introduction to these reports, that it is my belief that statistical information of the character here presented can be prepared and preserved for future reference and use only under the auspices of the government, and that such information should be procured and published periodically at intervals of twenty or thirty years as part of the record of industrial and national progress.

I have the honor to be, very respectfully, your obedient servant,

W. P. TROWBRIDGE,  
*Chief Special Agent.*

## TABLE OF CONTENTS.

---

	Page.
LETTER OF TRANSMITTAL.....	v
GRAND SUMMARY.....	1-12
COMPARISON WITH CENSUS OF 1870.....	2, 3
AVERAGE POWER OF WATER-WHEELS AND STEAM-ENGINES IN 1870 AND 1880.....	3
RELATION BETWEEN STEAM- AND WATER-POWER.....	3-6
RELATION OF PRODUCT TO POWER.....	6-9
RELATION BETWEEN THE AMOUNT OF POWER USED AND THE NUMBER OF HANDS EMPLOYED.....	9, 10
TABULAR STATEMENT OF POWER USED IN THE MANUFACTURE OF IRON AND STEEL BY STATES AND TERRITORIES.....	10-12

## LETTER OF TRANSMITTAL.

---

WASHINGTON, D. C., October 25, 1881.

Professor W. P. TROWBRIDGE,  
*Chief Special Agent.*

SIR: I have the honor to submit herewith the statistics of steam- and water-power used in the manufacture of iron and steel during the census year, from June 1, 1870, to May 31, 1880, embracing complete statistics of power for that year of (1) blast-furnaces, (2) rolling-mills, (3) Bessemer and open-hearth steel-works, (4) crucible, blister, and miscellaneous steel-works, and (5) bloomeries and forges. The establishments included under the respective heads are identical with those similarly classified in the *Statistics of Iron and Steel Production*, in Vol. II of the final reports on the Tenth Census; and the data from which the results herewith transmitted have been obtained were taken from the replies to inquiries relating to power contained in the schedules used by Mr. James M. Swank for the collection of the statistics of the manufacture of iron and steel.

Two sets of figures are given, referring, first, to water-wheels and steam-engines in actual operation during the whole or a part of the census year, 1880; and, second, to such as were not in operation during any portion of that year.

These statistics have been prefaced by a short report making such comparisons with the Census of 1870 as were deemed necessary. In this report I have also endeavored to show the relation between power and product and between amount of power used and number of hands employed.

The figures relating to production and number of hands employed have been taken from the *Statistics of Iron and Steel Production*, compiled by Mr. James M. Swank, special agent,

I am, sir, very respectfully, your obedient servant,

HERMAN HOLLERITH,  
*Special Agent*

v

# SUMMARY OF THE STATISTICS OF STEAM- AND WATER-POWER

## USED IN THE

### MANUFACTURE OF IRON AND STEEL.

The statistics of steam- and water-power used in the manufacture of iron and steel in the census year 1880 are herein summarized and compared, so far as possible, with the statistics of power reported in the Census of 1870.

#### GRAND SUMMARY.

In the following table the totals of the various iron and steel industries of the United States are given. Two sets of figures are shown, the first referring to such water-wheels and steam-engines as were actually in operation during the whole or a part of the census year 1880; the second set of figures refer to such water-wheels and steam-engines as were not in actual operation during any part of the census year.

Works.	NUMBER OF ESTABLISHMENTS.		WATER-POWER.				STEAM-POWER.						TOTAL HORSE-POWER.	
	In operation.	Not in operation.	Number of wheels.		Horse-power.		Number of boilers.		Number of engines.		Horse-power.		In operation.	Not in operation.
			In operation.	Not in operation.	In operation.	Not in operation.	In operation.	Not in operation.	In operation.	Not in operation.	In operation.	Not in operation.		
All iron- and steel-works .....	781	224	800	94	10,500	4,028	7,207	703	3,205	318	380,741	31,284	307,247	35,012
Blast-furnaces .....	340	150	02	47	3,827	1,983	2,038	442	882	178	133,470	17,514	130,803	10,407
Rolling-mills .....	283	41	131	22	8,325	2,100	3,830	244	1,020	130	104,007	12,675	203,702	14,776
Bessemer and open-hearth steel-works ..	33	3	.....	.....	.....	.....	453	5	251	1	30,241	500	30,241	500
Crucible and miscellaneous steel-works ..	35	2	0	.....	020	.....	222	0	110	3	14,585	365	15,205	305
Blomaries and forges .....	90	28	153	25	3,734	545	40	0	27	0	1,472	230	5,206	775

The total capacity of the 454 water-wheels reported was 21,134 horse-power, of which 94 water-wheels with a capacity of 4,028 horse-power, or 21.9 per cent. of the total capacity, were reported as having been idle during the entire census year; 3,523 steam-engines were reported, with a total capacity of 412,025 horse-power, of which 318 engines, equivalent to 31,284 horse-power, or 7.6 per cent. of the total capacity, were reported as not in operation during any part of the census year.

The total capacity of all steam-engines and water-wheels reported was 433,150 horse-power. The power of all steam-engines and water-wheels reported as not in operation during the census year was 35,912 horse-power, or 8.3 per cent. of the total capacity.

## POWER USED IN THE MANUFACTURE OF IRON AND STEEL.

The relation between the power in operation and not in operation during the census year in the various iron and steel industries is shown by the following table :

Works.	WATER-POWER.		STEAM-POWER.		TOTAL HORSE-POWER.	
	In operation.	Not in operation.	In operation.	Not in operation.	In operation.	Not in operation.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
All iron- and steel-works .....	78.10	21.90	92.41	7.59	91.71	8.29
Blast-furnaces .....	92.96	37.34	88.40	11.60	87.53	12.47
Rolling-mills .....	80.78	19.22	93.90	6.10	93.24	6.76
Bessemer and open-hearth steel-works .....			98.64	1.36	98.04	1.96
Crucible and miscellaneous steel-works .....	100.00		97.56	2.44	97.66	2.34
Blomaries and forges .....	87.26	12.74	86.49	13.51	87.04	12.96

The total of 35,912 horse-power, steam and water, which was reported as not in operation during the census year, is divided between the various iron and steel industries as follows, viz: Blast-furnaces, 54.29 per cent.; rolling-mills, 41.14 per cent.; Bessemer and open-hearth steel-works, 1.39 per cent.; crucible, blister, and miscellaneous steel-works, 1.02 per cent.; blomaries and forges, 2.16 per cent.

## COMPARISON WITH CENSUS OF 1870.

In the following table the power reported as used in the manufacture of iron and steel in 1880 is compared with the power reported in the Census of 1870, showing the percentages of increase and decrease :

Class of work.	Census Year.	WATER-POWER.		STEAM-POWER.		Total power.
		Number of wheels.	Horse-power.	Number of engines.	Horse-power.	
All iron- and steel-works .....	1880	360	16,508	3,205	380,741	397,247
	1870	393	16,584	1,807	154,091	170,675
Percentage of increase .....				134.38	147.09	132.75
Percentage of decrease .....		8.40	0.47			
Blast-furnaces .....	1880	92	3,327	882	133,476	136,803
	1870	141	5,034	509	53,896	63,930
Percentage of increase .....				73.28	126.75	114.09
Percentage of decrease .....		56.03	33.91			
Rolling-mills .....	1880	131	3,325	1,929	194,967	203,792
	1870	162	3,126	744	80,958	89,084
Percentage of increase .....			8.60	159.27	140.82	128.76
Percentage of decrease .....		19.14				
Steel-works .....	1880	9	920	307	50,326	51,446
	1870	6	250	83	11,557	11,807
Percentage of increase .....		50.00	148.00	342.17	339.70	335.72
Percentage of decrease .....						
Blomaries and forges .....	1880	153	3,734	27	1,472	5,206
	1870	84	3,174	31	2,710	5,384
Percentage of increase .....		88.10	17.64			
Percentage of decrease .....				12.90	45.68	11.52

In the Census of 1870 the number of boilers was not reported, hence no comparison can be made.

As the power used in the manufacture of steel was not divided in the Census of 1870, the power used in Bessemer and open-hearth steel-works in 1880 has been added to that used in crucible and miscellaneous steel-works for the purpose of comparison. In this industry the greatest percentage of increase, 336 per cent., is shown; this is due to the large increase in the production of Bessemer and open-hearth steel-works during the last decade, no open-hearth steel and only a comparatively small quantity of Bessemer steel being reported in the Census of 1870.

The next largest percentage of increase, 129 per cent. in the amount of power used, is shown in rolling-mills. The power used in blast-furnaces increased 114 per cent. The power used in blomaries and forges decreased 11.52 per cent.

The total amount of water-power used in 1870 and 1880 was practically the same, the decrease being only 0.47 per cent. The amount of steam-power used, however, increased 147 per cent., giving a total increase of 133 per cent., although the total water-power decreased but 0.47 per cent., the number of water-wheels in use decreased 8.4 per cent.; on the other hand, the number of steam-engines in use increased 134 per cent. These figures tend to show the gradual substitution of steam-power for water-power in the iron- and steel-works of this country.

## AVERAGE POWER OF WATER-WHEELS AND STEAM-ENGINES IN 1870 AND 1880.

*Water-wheels.*—The average power of the water-wheels reported in 1870 was 42.2 horse-power, in 1880 the average was 45.85 horse-power, showing an increase of 8.65 per cent. in the average power of wheels used.

*Steam-engines.*—In 1870 the average power of the steam-engines reported was 112.72 horse-power, in 1880 the average was 118.79 horse-power, showing an increase of 5.39 per cent. in the average power of engines used.

The following table gives the average power of water-wheels and steam-engines reported as used in the several iron and steel industries in 1880:

Works.	AVERAGE POWER.	
	Water-wheels.	Steam-engines.
	<i>Horse-power.</i>	<i>Horse-power.</i>
All iron- and steel-works .....	45.85	112.72
Blast-furnaces .....	53.00	151.83
Rolling-mills .....	07.37	101.07
Bessemer and open-hearth steel-works .....	.....	144.30
Crucible and miscellaneous steel-works .....	08.80	125.73
Blomaries and forges .....	23.03	54.52

## RELATION BETWEEN STEAM- AND WATER-POWER.

The following table shows the relative importance of steam- and water-power in the various iron and steel industries, as reported in the Censuses of 1880 and of 1870:

Works.	1880.		1870.	
	Water-power.	Steam-power.	Water-power.	Steam-power.
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
All iron- and steel-works .....	4.16	95.84	0.72	99.28
Blast-furnaces .....	2.43	07.57	7.88	02.12
Rolling-mills .....	4.33	05.07	0.12	00.88
Bessemer and open-hearth steel-works .....	.....	100.00	.....	.....
Crucible and miscellaneous steel-works .....	4.08	05.02	.....	.....
Blomaries and forges .....	71.72	23.28	53.04	40.00
All steel-works .....	1.21	93.79	2.12	07.88

From the foregoing table we see that the relative importance of water-power has decreased in all the iron and steel industries excepting blomaries and forges. In 1870, of the total amount of power used in blomaries and forges, 46 per cent. was steam-power, while in 1880 only 28 per cent. was steam-power. This is easily accounted for when we remember that the product of all the iron and steel industries increased, excepting that of blomaries and forges, which decreased 35 per cent. in the decade from 1870 to 1880.

Mr. Swank, in his *Statistics of Iron and Steel Production* says: "This decrease is due to the general substitution of improved processes for the forges and blomaries of our earlier iron history, and it would have been much greater in the decade mentioned if the improved American blomary, so largely used in northern New York, had not contributed its large product to swell the production of 1880." Hence we would naturally look to New York for this increase in the amount of water-power used. We find that the water-power used in New York in this industry has increased 500 horse-power, the total increase for the whole United States being only 500 horse-power. The northern part of New York state, where these blomaries are located, is peculiarly adapted to the development of water-power. As the cost of manufacturing with water-power is less than with steam-power, other things being equal, the advantages of water-power become more apparent as the competition increases.

The following table shows, first, the amount of water-power used in the iron and steel industries of the different states, as reported in the Censuses of 1880 and of 1870; second, the percentages of the total amount of

## POWER USED IN THE MANUFACTURE OF IRON AND STEEL.

water-power used in each state; third, the relative importances of steam- and water-power in each state in 1880 and 1870, giving the percentages of steam- and water-power; and, fourth, the percentages of increase and decrease in the amount of water-power used in each state.

States and territories.	1880.				1870.				Increase since 1870.	Decrease since 1870.
	Water-power.	Total water-power.	Water-power.	Steam-power.	Water-power.	Total water-power.	Water-power.	Steam-power.		
	Horse-power.	Per cent.	Per cent.	Per cent.	Horse-power.	Per cent.	Per cent.	Per cent.		
The United States.	16,560		4.16	95.84	16,564		0.72	99.28		0.47
Alabama				100.00	135	0.81	15.08	84.92		
California				100.00				100.00		
Colorado				100.00						
Connecticut	618	5.56	29.97	70.03	278	1.68	20.78	79.22	230.23	
Delaware	189	1.14	7.39	92.61	65	0.39	8.97	91.03	100.77	
District of Columbia				100.00						
Georgia	53	0.32	3.31	96.69	22	0.13	4.30	95.70	140.91	
Illinois				100.00				100.00		
Indiana				100.00				100.00		
Kansas				100.00						
Kentucky				100.00				100.00		
Maine	785	4.70	41.04	58.96	120	0.72	15.00	85.00	554.17	
Maryland	670	4.06	11.27	88.73	600	3.68	24.10	75.91	1.52	
Massachusetts	1,650	10.00	89.33	10.67	785	4.73	12.01	87.99	110.10	
Michigan	45	0.27	0.80	99.20	95	0.57	2.95	97.05		52.63
Missouri				100.00	60	0.40	2.40	97.60		
Nebraska				100.00						
New Hampshire				100.00						
New Jersey	1,198	7.25	8.01	91.99	1,080	6.51	20.00	80.00	10.74	
New York	4,799	28.93	15.78	84.22	5,718	34.43	31.11	68.89		17.65
North Carolina	259	1.63	100.00		362	2.18	75.59	24.41		30.11
Ohio	190	0.01	0.20	99.80	60	0.36	0.28	99.72	66.67	
Oregon	147	0.89	100.00							
Pennsylvania	3,713	22.40	1.85	98.15	3,864	23.30	4.08	95.92		3.90
Rhode Island				100.00				100.00		
South Carolina					111	0.67	100.00			
Tennessee	263	1.58	4.62	95.38	1,175	7.09	50.70	49.30		75.00
Texas				100.00						
Vermont	25	0.15	0.67	99.33	180	1.09	100.00			86.11
Virginia	1,598	9.67	80.97	19.03	1,598	9.64	70.53	29.47		0.13
West Virginia				100.00	20	0.12	0.46	99.54		
Wisconsin	104	0.63	3.44	96.56	190	1.15	17.51	82.49		13.63
Wyoming				100.00						

By this table we see that the relative importance of water-power has decreased since 1870 in each state in which it was used, except in the following: Maine, Massachusetts, Connecticut, North Carolina, and Virginia.

Of the total amount of power used in Maine in 1880, 42 per cent. was water-power, while in 1870 only 15 per cent. was water-power. In Massachusetts the percentage of water-power used increased from 13 per cent. in 1870 to 89 per cent. in 1880. In Connecticut the water-power was 30 per cent. in 1880 and 21 per cent. in 1870.

The relative economy in the use of water-power increases as the cost of fuel increases; hence, we should expect to find a larger percentage of water-power used in states where fuel is expensive. In addition to the relatively high cost of fuel in New England, the topography of the country is such as to afford abundant water-power; hence it is not surprising that those states should be an exception to the foregoing rule.

In North Carolina in 1880 no steam-power was used, while in 1870, of the total amount of power used in the state, 24 per cent. was steam-power. The total amount of power used in 1870 was 477 horse-power; in 1880 it was only 253 horse-power, showing a decrease of 47 per cent. Again, the production fell from 1,801 tons in 1870 to 439 tons in 1880. In 1870 several blast-furnaces, using steam-power, were in operation; but in 1880 the production of iron and steel was confined entirely to bloomeries and forges using water-power.

In Virginia we find that the percentage of water-power used had increased from 77 per cent. in 1870 to 81 per cent. in 1880. From 1870 to 1880 the total amount of power used decreased from 2,088 horse-power to 1,971 horse-power, or 5.6 per cent.; the total product, however, increased from 37,836 tons in 1870 to 55,722 tons in 1880. Notwithstanding this increase in the production, fewer establishments were engaged in the manufacture of iron and steel in 1880 than in 1870, there being but 19 establishments reported in 1880 as against 35 establishments in 1870.

The total amount of steam and water-power, the total amount of water-power, and the total amount of steam-power as reported in the Census of 1880 and in that of 1870, is divided in the following table between the different industries, showing percentage of the total amount used in each.

In the Census of 1870 the power used in steel-works was not divided; hence no figures are given for Bessemer and open-hearth steel-works, nor for crucible steel-works for 1870. The percentage used in the manufacture of steel, all kinds, is, however, given for 1870. For 1880 the percentage used in Bessemer and open-hearth steel-works has been added to that used in crucible and miscellaneous steel-works.

Works.	TOTAL HORSE-POWER.		TOTAL WATER-POWER.		TOTAL STEAM-POWER.	
	1880.	1870.	1880.	1870.	1880.	1870.
	307,247 H. P.	170,075 H. P.	10,500 H. P.	10,584 H. P.	380,741 H. P.	170,075 H. P.
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Blast-furnaces .....	34.44	37.44	20.10	30.35	35.00	38.20
Rolling-mills.....	51.30	52.19	53.40	49.00	51.21	52.54
Bessemer and open-hearth steel-works.....	0.12				0.52	
Crucible and miscellaneous steel works.....	3.83		3.70		3.83	
Blomaries and forges .....	1.31	0.45	22.62	10.14	0.38	1.76
All steel-works .....	<i>α</i> 12.95	0.02	<i>α</i> 3.70	1.51	<i>α</i> 12.35	7.50

*α* These figures were obtained by adding percentage for Bessemer and open-hearth steel-works to crucible and miscellaneous steel-works.

The following table gives the total amount of power used in the manufacture of iron and steel, as reported in the Censuses of 1880 and of 1870, the relative rank in production, the percentage of the total amount of power used, and the percentage of increase and decrease for each state that produced iron or steel in the census years 1870 or 1880:

States and territories.	1880.			1870.			Percentage of increase since 1870.
	Rank in production.	Total power.	Percentage of total power.	Rank in production.	Total power.	Percentage of total power.	
The United States.....		307,247			170,075		182.75
			<i>Per cent.</i>				<i>Per cent.</i>
Pennsylvania.....	1	201,222	50.07	1	82,032	48.42	143.53
Ohio.....	2	50,070	12.83	2	21,331	12.60	138.01
New York.....	3	29,817	7.51	3	18,379	10.77	64.40
Illinois.....	4	17,852	4.40	15	3,075	2.16	385.77
New Jersey.....	5	14,935	3.70	4	5,400	3.18	170.57
Wisconsin.....	6	4,704	1.20	12	1,085	0.64	330.07
West Virginia.....	7	8,000	2.10	10	4,305	2.68	55.08
Michigan.....	8	5,240	1.32	8	3,224	1.80	62.53
Massachusetts.....	9	15,471	3.89	9	6,225	3.63	148.53
Missouri.....	10	5,015	1.49	6	2,647	1.55	123.46
Kentucky.....	11	6,400	1.61	7	3,900	2.29	64.10
Maryland.....	12	5,046	1.50	5	2,728	1.60	117.06
Indiana.....	13	4,405	1.13	11	4,940	2.89	<i>α</i> 9.01
Tennessee.....	14	6,338	1.60	14	2,315	1.36	173.78
Alabama.....	15	2,400	0.60	20	805	0.63	108.15
Virginia.....	16	1,971	0.50	13	2,088	1.23	<i>α</i> 5.00
Connecticut.....	17	3,068	0.77	10	1,338	0.78	128.02
Georgia.....	18	1,590	0.40	16	612	0.36	212.30
Delaware.....	19	2,650	0.64	10	725	0.42	252.07
Kansas.....	20	1,900	0.48				
California.....	21	600	0.15	22	225	0.13	100.07
Maine.....	22	1,885	0.48	17	800	0.47	135.02
Wyoming.....	23	455	0.12				
Rhode Island.....	24	420	0.11	21	425	0.25	<i>α</i> 11.70
New Hampshire.....	25	755	0.19				
Vermont.....	26	375	0.09	24	180	0.11	168.33
Colorado.....	27	315	0.08				
Oregon.....	28	147	0.04				
Nebraska.....	29	300	0.08				
Texas.....	30	60	0.02				
North Carolina.....	31	253	0.06	23	477	0.28	<i>α</i> 40.00
District of Columbia.....	32	135	0.03				
South Carolina.....				25	111	0.07	

*α* Decrease.

## POWER USED IN THE MANUFACTURE OF IRON AND STEEL.

Dividing the whole territory of the United States into four grand divisions, as follows, viz, eastern states southern states, western states and territories, and Pacific states and territories, we have the following statistics of power used in the several divisions :

Divisions.	Number of establishments.	WATER-POWER.		STEAM-POWER.			Total horse-power.
		Number of wheels.	Horse-power.	Number of boilers.	Number of engines.	Horse-power.	
The United States .....	781	800	10,506	7,297	9,205	380,741	307,247
Eastern states .....	480	209	12,906	5,107	2,041	255,037	268,033
Southern states .....	132	81	3,054	692	315	83,207	36,201
Western states and territories ..	165	9	309	1,438	810	91,127	91,436
Pacific states and territories .....	4	1	147	60	30	1,370	1,517

The following table gives the percentage of the total power used in each of the divisions :

Divisions.	Total horse-power.	Total water-power.	Total steam-power.
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Eastern states .....	67.47	78.74	66.98
Southern states .....	9.13	18.50	8.72
Western states and territories .....	23.02	1.87	23.94
Pacific states and territories .....	0.38	0.89	0.36

The relation between steam- and water-power in each of the divisions is shown in the following table :

Divisions.	Water-power.	Steam-power.
	<i>Per cent.</i>	<i>Per cent.</i>
Eastern states .....	4.85	95.15
Southern states .....	8.42	91.58
Western states and territories .....	0.34	99.66
Pacific states and territories .....	0.60	99.31

From this we see that the relative importance of water-power, as compared with steam-power, is greatest in the southern and Pacific states and territories. The largest amount of water-power, however, was used in the eastern states, being 78.74 per cent. of the whole.

The following is the average power of water-wheels reported : Eastern states, 48.3 horse-power ; southern states, 37.7 horse-power ; western states and territories, 34.3 horse-power ; in the Pacific states and territories but one wheel of 147 horse power is reported.

The average power of the steam-engines reported is as follows : Eastern states, 125 horse-power ; southern states, 105.4 horse-power ; western states and territories, 111.3 horse-power ; Pacific states and territories, 44.3 horse-power.

## RELATION OF PRODUCT TO POWER.

The following table shows the number of tons, per horse-power, produced in the different iron and steel industries in 1880 and 1870 :

Works.	1880.			1870.		
	Total product.	Total power.	Produced per horse-power.	Total product.	Total power.	Produced per horse-power.
	<i>Tons.</i>	<i>Horse-power.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Horse-power.</i>	<i>Tons.</i>
All iron- and steel-works .....	7,265,140	397,247	18.29	3,055,215	170,675	21.42
Cast-furnaces .....	3,781,021	186,803	27.04	2,052,821	63,930	32.13
Rolling-mills .....	2,353,248	203,792	11.55	1,441,829	89,084	16.19
Bessemer and open-hearth steel-works .....	983,039	30,241	27.12	40,757	11,807	4.21
Crucible and miscellaneous steel-works .....	75,275	15,205	4.95			
Blowpipes and forges .....	72,557	5,206	13.94	110,808	5,884	18.83
All steel-works .....	11,058,314	651,440	20.37	40,757	11,807	4.21

<sup>a</sup> These figures are obtained by adding together the figures for Bessemer and open-hearth and crucible and miscellaneous steel-works.

POWER USED IN THE MANUFACTURE OF IRON AND STEEL.

the product per horse-power for all iron and steel works was 21.42 tons, in 1880 it was 18.29 tons, decrease of 3.13 tons or 14.6 per cent. in the product per horse-power. Product of blast-furnaces in 1870 was 32.13 tons per horse-power, and in 1880 it was 27.64 tons, showing a decrease of 4.49 tons, or 26.6 per cent. in the product per horse-power. Product per horse-power of rolling-mills was 16.19 tons in 1870 and 11.55 tons in 1880, showing a decrease of 4.64 tons, or 28.7 per cent. Product per horse-power of steel-works in 1870 was 4.21 tons; in 1880 the product was 20.57 tons per horse-power; this increase is due to the large quantities of Bessemer and open-hearth steel made in 1880. Product per horse-power of bloomeries and forges in 1870 was 18.83 tons; in 1880 it was 13.94 tons, showing a decrease of 4.9 tons, or 26 per cent. in the product per horse-power. Comparison between product and power in the three states producing the largest amount of iron and steel in the year 1880 is shown in the following table:

Works.	PENNSYLVANIA.			OHIO.			NEW YORK.					
	Months in operation.	Total product.	Total power.	Tons per horse-power.	Months in operation.	Total product.	Total power.	Tons per horse-power.	Months in operation.	Total product.	Total power.	Tons per horse-power.
Open-hearth steel-works	9	1,930,811	72,223	26.73	9	548,712	25,368	21.61	9	313,308	11,985	26.15
Open-hearth steel-works	10	1,071,098	96,502	11.09	0	272,604	23,002	11.78	8	103,538	11,907	19.03
Open-hearth steel-works	12	531,881	19,730	26.96	10	108,075	2,400	45.41	12	87,165	2,675	32.58
Blast-furnaces	11	58,805	11,041	5.33	4	360	90	4.00	0	2,511	1,050	2.39
Rolling-mills	9	24,573	1,690	14.49	.....	.....	.....	.....	10	31,718	2,140	14.82

Following table shows the relation between product and power in the four grand divisions of the United States:

Divisions.	Total product.	Total power.	Tons per horse-power.
The United States.....	7,265,140	397,247	18.29
Eastern states.....	4,071,608	208,033	17.43
Southern states.....	648,153	36,261	17.90
Western states and territories.....	1,012,680	91,486	20.02
Pacific states and territories.....	534,000	1,517	20.76

Comparison between product and power in the different states for the census years 1880 and 1870 is shown in the following table:

States.	1880.						1870.						
	Months in operation.	Rank in production.	Total production.	Total power.	PERCENTAGE.		Produced per horse-power.	Rank in production.	Total production.	Total power.	PERCENTAGE.		Produced per horse-power.
					Total product.	Total power.					Total product.	Total power.	
U.S.	.....	.....	7,265,140	397,247	.....	.....	18.29	.....	3,655,215	170,075	.....	.....	21.42
.....	9	1	3,016,068	201,282	49.78	50.67	17.07	1	1,830,808	82,652	50.25	48.42	22.22
.....	9	2	930,141	50,970	12.80	12.83	16.25	2	449,768	21,834	12.30	12.50	21.08
.....	9	3	598,300	29,847	8.24	7.51	20.05	3	448,257	18,979	12.20	10.77	24.30
.....	9	4	417,907	17,852	5.75	4.40	23.41	15	23,761	3,675	0.71	2.15	7.01
.....	9	5	243,800	14,985	3.36	3.76	16.33	4	115,262	5,400	3.15	3.16	21.34
.....	10	6	178,935	4,764	2.40	1.20	37.50	12	42,234	1,085	1.16	0.64	38.03
.....	7	7	147,487	8,000	2.03	2.16	17.15	10	72,337	4,305	1.98	2.58	16.46
.....	10	8	142,716	5,240	1.96	1.32	27.24	8	86,679	3,224	2.37	1.89	26.30
.....	9	9	141,321	15,471	1.95	3.89	9.18	9	86,146	9,225	2.36	3.65	13.34
.....	9	10	125,758	5,915	1.73	1.40	21.26	6	94,890	2,647	2.00	1.55	35.85
.....	9	11	123,751	6,400	1.70	1.61	10.33	7	86,732	3,900	2.37	2.29	22.24
.....	8	12	110,034	5,946	1.53	1.50	18.66	5	95,424	2,728	2.61	1.60	34.08
.....	10	13	96,117	4,495	1.32	1.13	21.33	11	64,148	4,040	1.76	2.30	12.99
.....	7	14	77,100	6,338	1.06	1.00	12.17	14	94,305	2,315	0.94	1.36	14.32
.....	10	15	62,936	2,400	0.87	0.60	26.24	20	7,000	805	0.19	0.52	7.30
.....	7	16	55,722	1,971	0.77	0.50	28.27	18	37,836	2,088	1.04	1.22	16.12

## POWER USED IN THE MANUFACTURE OF IRON AND STEEL.

States and territories.	1880.							1870.						
	Months in operation.	Rank in production.	Total production.	Total power.	PERCENTAGE.		Produced per horse-power.	Rank in production.	Total production.	Total power.	PERCENTAGE.		Produced per horse-power.	
					Total product.	Total power.					Total product.	Total power.		
			Tons.	Horse-power.	Per cent.	Per cent.	Tons.	Tons.	Horse-power.	Per cent.	Per cent.	Tons.		
Connecticut.....	10	17	38,061	8,003	0.52	0.77	12.43	16	25,305	1,338	0.69	0.78	18.01	
Georgia.....	0	18	35,102	1,590	0.48	0.40	21.08	18	9,634	512	0.26	0.30	18.81	
Delaware.....	11	10	33,018	2,550	0.47	0.51	13.25	10	8,307	725	0.23	0.42	11.45	
Kansas.....	5	20	10,055	1,000	0.26	0.48	10.03							
California.....	12	21	14,000	600	0.19	0.15	23.83	22	3,000	225	0.08	0.19	13.33	
Maine.....	7	22	10,500	1,885	0.15	0.48	5.76	17	17,138	890	0.47	0.47	21.43	
Wyoming.....	0	28	9,700	455	0.15	0.12	21.52							
Rhode Island.....	10	24	8,194	420	0.11	0.11	19.27	21	4,415	425	0.12	0.25	10.99	
New Hampshire.....	12	25	7,078	755	0.11	0.19	10.57							
Vermont.....	7	26	6,020	375	0.09	0.09	17.05	24	1,525	150	0.04	0.11	8.47	
Colorado.....	4	27	4,500	315	0.06	0.08	14.29							
Oregon.....	9	28	3,200	147	0.04	0.04	21.77							
Nebraska.....	10	29	2,000	300	0.03	0.08	6.67							
Texas.....	0	30	1,400	60	0.02	0.02	23.33							
North Carolina.....	7	31	480	253	0.005	0.06	1.74	23	1,801	477	0.05	0.28	3.78	
District of Columbia.....	6	32	264	135	0.005	0.03	1.96							
South Carolina.....								25	443	111	0.01	0.07	3.09	

In the following table this same relation between product and power is shown for all counties in the United States producing 80,000 tons and upward of iron or steel, or using 4,000 horse-power or more:

Counties.	States.	Months in operation.	Total product.	Total power.	Produced per horse-power.
			Tons.	Horse-power.	Tons.
Allegheny.....	Pennsylvania.....	10	848,140	65,927	12.98
Lehigh.....	do.....	10	324,875	15,150	21.44
Northampton.....	do.....	11	322,882	11,530	28.00
Cambridge.....	do.....	12	260,140	17,013	15.20
Cook.....	Illinois.....	10	248,470	11,062	20.77
Dauphin.....	Pennsylvania.....	10	223,076	4,927	45.45
Mahoning.....	Ohio.....	10	219,057	12,725	17.23
Berks.....	Pennsylvania.....	9	213,580	9,510	22.44
Cuyahoga.....	Ohio.....	9	210,454	7,200	29.22
Mercer.....	Pennsylvania.....	9	182,831	6,274	29.15
Rensselaer.....	New York.....	11	177,967	7,460	23.86
Montgomery.....	Pennsylvania.....	9	168,628	7,610	22.16
Lackawanna.....	do.....	11	151,273	14,729	10.27
Milwaukee.....	Wisconsin.....	11	128,191	3,320	38.56
Saint Louis.....	Missouri.....	7	102,644	5,585	18.38
Lawrence.....	Pennsylvania.....	8	83,443	4,069	22.06
Leicester.....	do.....	8	87,019	3,753	23.19
Ohio.....	West Virginia.....	10	84,707	5,658	14.98
Will.....	Illinois.....	12	84,004	2,056	40.90
Chester.....	Pennsylvania.....	9	78,363	5,967	13.33
Trumbull.....	Ohio.....	10	73,366	4,320	16.91
Lebanon.....	Pennsylvania.....	11	73,140	4,170	17.54
Lawrence.....	Ohio.....	11	70,704	4,450	15.88
Philadelphia.....	Pennsylvania.....	9	65,983	5,168	12.77

In the foregoing tables, showing the relation of product to power, there are great variations in the amount produced per horse-power. Thus, in Illinois the product is 23.41 tons per horse-power, while in Massachusetts it is but 9.13 tons per horse-power. This apparent discrepancy is explained by the fact that the average production per horse-power for blast-furnaces is 27.64 tons; for Bessemer and open-hearth steel-works, 27.12 tons per horse-power; while for rolling-mills it is only 11.55 tons. By an examination of the *Statistics of Iron and Steel Production*, it is found that in Illinois 49.12 per cent. of the total product is from Bessemer and open-hearth steel-works, 22.84 per cent. from blast-furnaces, and 28.01 per cent. from rolling-mills; hence it is not surprising to find here a much larger product per horse-power than in Massachusetts, where of the total product, 77.31 per cent. is produced in rolling-mills; 6.75 per cent. in blast-furnaces, and 15.81 per cent. in Bessemer and open-hearth steel-works. Again, the product per horse-power will not only vary with the different iron and steel industries, but also with different establishments of the same kind according to the character of the product. Thus, a rolling-mill producing large sizes of bar-iron and other large units will not require as much power per ton of product as a mill producing small

rods, hoop-iron, cut-nails, and the like. By a glance at the statistics of production of rolling-mills, we see that the product of the Massachusetts rolling-mills is largely composed of rods, hoop-iron, cut-nails, fish-plates, and such other products as would tend to increase the relative amount of power used. Again, in Massachusetts a large proportion of the power reported is water-power; hence it is very probable that much of the steam-power used is merely as an auxiliary during the dry season. Therefore the total amount of power reported may be somewhat in excess of the amount actually in use in the manufacture of iron and steel.

In examining these figures, the time which the different establishments were in actual operation must be considered. For 1880 the average number of months in operation has been given; unfortunately, this cannot be done for 1870, as no provision was made in the Ninth Census for this item.

On examination of the table on page 7 we find that during 1880 the largest production per horse-power was in the state of Wisconsin, being 37.56 tons. The *Statistics of Iron and Steel Production* show that 66.1 per cent. of the total product was produced in blast-furnaces, and 33.9 per cent. in rolling-mills; the 60,653 tons of rolling-mill product consisted of 31,101 tons of bar-iron, and 29,552 tons of iron rails, all of which was produced by one establishment. The 118,282 tons of pig-iron were produced by 13 blast-furnace stacks, giving an average annual production of 9,099 tons per stack. The average production per stack in Pennsylvania was 8,179 tons; in Ohio, 6,611 tons, and in New York, 6,964 tons.

This will easily account for the very large production per horse-power, as the rolling-mills and blast-furnaces were running under very favorable circumstances as regards the economy of power.

RELATION BETWEEN THE AMOUNT OF POWER USED AND THE NUMBER OF HANDS EMPLOYED.

The following table shows the relation between the power used and the number of hands employed in the various iron and steel industries of the United States for the census years 1880 and 1870:

Works.	1880.			1870.		
	Total power.	Number of hands employed.	Horse-power per hand.	Total power.	Number of hands employed.	Horse-power per hand.
All iron- and steel-works .....	<i>Horse-power.</i> 807,247	140,978	2.82	<i>Horse-power.</i> 170,675	77,555	2.20
Blast-furnaces .....	186,803	41,875	3.27	63,000	27,554	2.32
Rolling-mills .....	208,792	80,133	2.54	80,084	44,002	1.99
Bessemer and open-hearth steel-works .....	86,241	10,885	3.34	11,807	2,437	4.84
Crucible and miscellaneous steel-works .....	15,295	5,190	2.93			
Blomaries and forges .....	5,206	2,939	1.77	5,884	2,902	2.03
All steel-works .....	51,446	10,031	3.21	11,807	2,487	4.84

The above table shows that for all iron and steel industries the ratio of power used to hands employed increased from 2.20 horse-power in 1870 to 2.82 horse-power in 1880, or an increase of 27 per cent.; in blast-furnaces: this ratio was 2.32 horse-power in 1870, and 3.27 horse-power in 1880, showing an increase of 41 per cent.; for rolling-mills this increase was from 1.99 horse-power in 1870 to 2.54 horse-power in 1880, or 28 per cent.; in blomaries: and forges the amount of power used to each hand employed decreased from 2.03 horse-power in 1870 to 1.77 horse-power in 1880, or 13 per cent.

The following table shows the same relation in the states of Pennsylvania, Ohio, and New York:

Works.	PENNSYLVANIA.			OHIO.			NEW YORK.		
	Number of hands employed.	Total power.	Horse-power per hand.	Number of hands employed.	Total power.	Horse-power per hand.	Number of hands employed.	Total power.	Horse-power per hand.
All iron- and steel-works .....	57,952	<i>Horse-power.</i> 201,282	3.47	20,071	<i>Horse-power.</i> 50,970	2.54	11,444	<i>Horse-power.</i> 20,847	2.07
Blast-furnaces .....	13,400	72,223	5.37	8,044	25,388	2.84	2,518	11,985	4.76
Rolling-mills .....	34,998	66,592	2.70	10,200	23,092	2.25	5,532	11,997	2.17
Bessemer and open-hearth steel-works .....	4,754	19,730	4.15	821	2,400	2.92	1,650	2,675	1.62
Crucible and miscellaneous steel-works .....	4,080	11,041	2.71	40	90	2.25	255	1,050	4.12
Blomaries and forges .....	600	1,096	2.57				1,480	2,140	1.44

On comparing the statistics of power used in manufacture with the statistics of production of iron and steel, there appears to be a discrepancy between the increase in the total amount of power used and the increase in the total weight of all products. Thus the increase in the total amount of power used was 132.75 per cent., while the

increase in total weight of all products was only 98.76 per cent. The increase in value of all materials used was 41 per cent.; the increase in value of products was 43 per cent. That is to say, the increase in the value of raw materials in process of manufacture was relatively greater in 1880 than in 1870. This might be due to the fact that the expenditure for wages was relatively greater, but we find that the total amount paid in wages increased only 36.93 per cent. As the use of machinery increases, the amount of power used will increase proportionately. These facts indicate the introduction of mechanical processes and labor-saving machinery, which we know to have been the case.

Although the average production per horse-power has decreased from 21.4 tons in 1870 to 18.3 tons in 1880, the average production to each hand employed has increased from 47.1 tons in 1870 to 51.5 tons in 1880. This is undoubtedly largely due to the fact that the amount of power used to each hand employed has increased from 2.2 horse-power in 1870 to 2.8 horse-power in 1880.

TABLE SHOWING POWER USED IN THE MANUFACTURE OF IRON AND STEEL.

Census year 1880.	NUMBER OF ESTABLISHMENTS.		WATER-POWER.				STEAM-POWER.						TOTAL HORSE-POWER.	
	In operation.	Not in operation.	Number of wheels.		Horse-power.		Number of boilers.		Number of engines.		Horse-power.		In operation.	Not in operation.
			In operation.	Not in operation.	In operation.	Not in operation.	In operation.	Not in operation.	In operation.	Not in operation.	In operation.	Not in operation.		
<b>BLAST-FURNACES.</b>														
The United States.....	840	150	62	47	3,827	1,983	2,683	442	882	178	138,470	17,514	136,863	10,407
Alabama.....	7	5		2		50	30	14	16	5	2,140	410	2,140	400
Connecticut.....	6	2	0		413		2	3	1	1	60	60	473	00
Georgia.....	5	4		2		85	15	3	5	2	1,000	150	1,000	185
Illinois.....	3	4					38	32	16	11	2,045	2,067	2,045	2,067
Indiana.....	8						17		7		675		675	
Kentucky.....	9	10					51	25	24	14	1,325	1,178	1,325	1,178
Maine.....	1		2		185								185	
Maryland.....	12	4	5	1	220	40	58	8	20	0	1,531	215	1,751	256
Massachusetts.....	2	2	1	1	40	20	12	3	5	2	220	40	200	60
Michigan.....	18	7	2	2	45	60	60	13	45	12	2,095	610	2,140	670
Minnesota.....		1						4		2		140		140
Missouri.....	4	8		3		180	51	17	22	0	2,180	753	2,130	933
New Jersey.....	12	1	3		325		101	9	18	4	5,224	170	5,540	170
New York.....	80	9	8	8	572	483	296	66	50	8	11,413	1,000	11,388	1,433
North Carolina.....		5		6		245		7		4		200		445
Ohio.....	22	20					400	61	162	26	25,388	3,133	25,388	3,133
Oregon.....	1		1		147								147	
Pennsylvania.....	186	81	20	6	1,030	138	1,488	128	422	40	71,193	4,785	72,223	4,923
Tennessee.....	9	9	2	3	20	04	33	10	14	7	1,810	908	1,836	972
Texas.....	1						1		1		60		60	
Utah.....		2		1		80		1		1		20		100
Vermont.....	1		1		25								25	
Virginia.....	8	21	5	10	135	548	13	24	6	11	260	665	395	1,208
West Virginia.....	8	4		2		65	41	8	18	2	3,167	65	3,167	160
Wisconsin.....	7	1	6		164		33	2	21	2	1,740	50	1,904	50
<b>ROLLING-MILLS.</b>														
The United States.....	283	41	131	22	8,825	2,100	8,836	244	1,620	130	194,367	12,675	203,792	14,775
Alabama.....	1	1					5		4		360		200	
California.....	1						43		16		600		600	
Colorado.....	1						7		4		315		315	
Connecticut.....	8		4		225		30		17		1,515		3,740	
Delaware.....	7	2	2		180		63	5	32	5	2,370	400	2,550	400
Distict of Columbia.....	1						8		2		135		135	
Georgia.....	1	1					18	10	0	2	540	300	540	300
Illinois.....	7	1					74	6	68	1	8,372	250	8,372	250
Indiana.....	7	2					60	17	53	20	3,820	1,220	3,820	1,220
Kansas.....	2						21		12		1,000		1,000	
Kentucky.....	7	1					93	15	60	12	5,050	1,350	5,050	1,350
Maine.....	2		4		600		33		10		1,100		1,700	
Maryland.....	5		0		450		31		48		3,687		4,137	
Massachusetts.....	18	4	87	4	1,590	300	307	23	103	10	18,001	850	14,591	1,150
Michigan.....	2						42		18		3,100		3,100	
Missouri.....	4	2					30	0	17	8	1,485	2,600	1,485	2,600
Nebraska.....	1						5		5		300		300	

Table showing power used in the manufacture of iron and steel—Continued.

Census year 1880.	NUMBER OF ESTABLISHMENTS.		WATER-POWER.				STREAM-POWER.						TOTAL HORSE-POWER.		
			Number of wheels.		Horse-power.		Number of boilers.		Number of engines.		Horse-power.				
	In operation.	Not in operation.	In operation.	Not in operation.	In operation.	Not in operation.	In operation.	Not in operation.	In operation.	Not in operation.	In operation.	Not in operation.	In operation.	Not in operation.	
<b>ROLLING-MILLS—Continued.</b>															
New Hampshire	1						27		10			745		745	
New Jersey	12	2	11	8	445	1,000	100	13	98	4		6,575	450	7,020	1,450
New York	10	4	22	6	2,812	201	206	10	120	6		9,685	400	11,007	601
Ohio	84	10	1		100		411	73	256	35		22,002	3,050	23,002	3,050
Pennsylvania	124	7	29		1,545		1,824	52	876	24		95,047	1,305	96,502	1,305
Rhode Island	1	1					14	8	5	3		420	500	420	500
Tennessee	4						35		23			3,163		3,163	
Utah		1		1		80									80
Virginia	3	2	15	3	1,869	519	1		1			40		1,409	519
West Virginia	8						62		32			5,433		5,433	
Wisconsin	1						35		32			2,800		2,800	
Wyoming	1						10		10			455		455	
<b>BESSEMER AND OPEN-HEARTH STEEL-WORKS.</b>															
The United States	33	3					459	5	251	1		80,241	500	30,241	500
Illinois	5						85		44			7,411		7,411	
Kentucky	1						1		1			15		15	
Massachusetts	2						5		2			450		450	
Missouri	1						34		10			2,200		2,200	
New Hampshire	1						3		1			10		10	
New Jersey	a 1														
New York	2						59		47			2,075		2,075	
Ohio	5						37		20			2,400		2,400	
Pennsylvania	13	2					213	5	113	1		10,730	500	10,730	500
Rhode Island		1													
Tennessee	1						6		3			1,000		1,000	
Vermont	1						10		1			350		350	
<b>CRUCIBLE AND MISCELLANEOUS STEEL-WORKS.</b>															
The United States	35	2	9		620		222	6	110	3		14,585	305	15,205	305
Connecticut	3		4		280		14		4			570		850	
Illinois	1						1		1			24		24	
Kentucky	1						1		1			10		10	
Maryland		1						1	1	1			15		15
Massachusetts	1						4		2			150		150	
New Jersey	4	1	3		200		23	5	13	2		1,700	350	1,000	350
New York	3						26		10			1,050		1,050	
Ohio	2						2		1			90		90	
Pennsylvania	20		2		140		146		84			10,901		11,041	
<b>BLOMRIES AND FORGES.</b>															
The United States	90	28	158	25	3,734	545	49	6	27	6		1,472	230	5,200	775
Georgia	3		4		53		1		1			0		50	
Maryland	1						10		1			58		58	
Massachusetts	1		1		20									20	
Missouri	1	2		2		120	3	1	2	1		100	25	100	145
New Jersey	7		9		226		3		4			150		370	
New York	20	2	52	1	1,825	30	9		5			315		2,140	30
North Carolina	6	9	13	3	253	40		1		1			15	253	55
Ohio		1						1		1			100		100
Pennsylvania	28	5	50	8	908	158	18		11			698		1,000	158
Tennessee	15	5	20	0	267	102	1		1			79		337	102
Vermont		2		2		40		3		3			90		130
Virginia	8	2	9	3	92	55	4		2			75		167	55

a The power of this establishment is included in crucible steel-works.

POWER USED IN THE MANUFACTURE OF IRON AND STEEL.

Table showing power used in the manufacture of iron and steel—Continued.

Census year 1880.	NUMBER OF ESTABLISHMENTS.		WATER-POWER.				STEAM-POWER.						TOTAL HORSE-POWER.	
			Number of wheels.		Horse-power.		Number of boilers.		Number of engines.		Horse-power.			
	In operation.	Not in operation.	In operation.	Not in operation.	In operation.	Not in operation.	In operation.	Not in operation.	In operation.	Not in operation.	In operation.	Not in operation.	In operation.	Not in operation.
<b>BY STATES.</b>														
The United States .....	781	224	860	94	16,506	4,628	7,237	703	3,205	318	380,741	31,284	397,247	35,912
Alabama .....	8	0		2		50	44	14	20	5	2,460	410	2,400	400
California .....	1						43		16		600		600	
Colorado .....	1						7		4		315		315	
Connecticut .....	17	2	14		918		46	8	22	1	2,145	60	3,063	60
Delaware .....	7	2	2		180		63	5	32	5	2,370	400	2,550	400
District of Columbia .....	1						3		2		185		185	
Georgia .....	9	5	4	2	55	85	34	13	15	4	1,546	450	1,500	483
Illinois .....	16	5					198	38	127	13	17,852	3,217	17,852	3,217
Indiana .....	10	2					77	17	60	20	4,405	1,220	4,405	1,220
Kansas .....	2						21		12		1,000		1,000	
Kentucky .....	18	11					146	40	76	26	6,400	2,523	6,400	2,523
Maine .....	3		6		785		33		10		1,300		1,885	
Maryland .....	18	5	11	1	670	40	145	9	69	7	5,276	230	5,046	270
Massachusetts .....	24	8	30	5	1,050	320	328	26	112	12	13,821	800	15,471	1,210
Michigan .....	15	7	2	2	45	60	92	13	63	12	5,195	610	5,240	670
Minnesota .....		1						4		2		140		140
Missouri .....	10	12		5		300	118	24	69	18	5,915	3,378	5,915	3,378
Nebraska .....	1						5		5		300		300	
New Hampshire .....	2						30		11		755		755	
New Jersey .....	30	4	26	8	1,106	1,000	331	27	133	10	13,730	970	14,035	1,070
New York .....	74	16	82	15	4,709	664	626	82	241	14	25,138	1,400	29,847	2,054
North Carolina .....	6	14	13	9	253	285		8		5		215		253
Ohio .....	103	31	1		170		850	135	436	62	50,870	6,283	50,970	6,283
Oregon .....	1		1		147									147
Pennsylvania .....	321	45	101	14	3,713	236	3,680	185	1,506	74	197,569	6,536	201,282	6,886
Rhode Island .....	1	2					14	8	5	3	420	500	420	500
Tennessee .....	26	14	22	9	293	160	75	10	41	7	6,045	908	6,338	1,974
Texas .....	1						1		1		60		60	
Utah .....		3		2		160		1		1		20		180
Vermont .....	2	2	1	2	25	40	10	3	1	3	350	60	375	130
Virginia .....	10	25	20	10	1,596	1,117	18	24	9	11	375	605	1,971	1,782
West Virginia .....	10	4		2		95	103	3	50	2	8,000	65	8,000	160
Wisconsin .....	8	1	6		164		68	2	33	2	4,660	50	4,764	50
Wyoming .....	1						10		10		455		455	